AoA Handbook

A Guide for Performing an Analysis of Alternatives (AoA)

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Preface

This ***Analysis of Alternatives (AoA) Handbook*** is produced by the Office of Aerospace Studies, Air Force Materiel Command, the designated Air Force Center of Expertise for AoAs. It embodies our current guidance for planning and executing Air Force and Air Force-led AoAs within the Department of Defense (DoD) acquisition process.

We revise this handbook to reflect any major evolution in the constantly changing acquisition process. We'd also like to hear what you think about the ***AoA Handbook***, especially if you have suggestions for improvements in organization, accuracy, and content.

A current copy of this document is always available at our web site, www.oas.kirtland.af.mil.

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1 Introduction

The Department of Defense (DoD) acquisition cycle is a structured, rational process designed to identify the best system to meet validated needs.

There are four milestones in the acquisition process. With each milestone is a decision point where the acquisition can be continued, revised, or cancelled. Each milestone may initiate an analysis of alternatives (AoA).

AoAs are an important element of the defense acquisition process. In the Air Force, the AoA has taken on an increasingly important role in determining whether or not a system should be procured. Air Force AoAs must not only make a case for having identified the most cost-effective alternative, they must also make a compelling statement about the military utility of acquiring it. In short, the AoA has become a vehicle used by senior Air Force leadership to debate and assess a program's desirability and affordability.

An AoA is an analytical comparison of the operational effectiveness and cost of proposed materiel solutions to shortfalls in operational capability (these shortfalls are also known as mission needs). AoAs document the rationale for identifying a preferred solution or solutions to the shortfalls. Deficiencies, advances in technology, or the obsolescence of existing systems can trigger an AoA. This handbook deals with Air Force-specific AoAs and Joint AoAs where the Air Force is designated as the lead service.

AoAs are required as part of the acquisition process for some acquisition programs. For other programs, AoAs may be directed because they are Joint, command special interest, or have high visibility.

AoAs are designated as AoA I, II, III, or IV depending on where in the acquisition cycle they occur. An AoA I, the most common, is conducted before an acquisition program is established. An AoA I typically explores numerous conceptual solutions with the goal of identifying one or more promising options. An AoA II occurs after a program is established and provides a more detailed definition and comparison of remaining options. An AoA III and AoA IV occur still later (if at all) to investigate the impact of new threats or technological advances to the ongoing program.

This handbook focuses on the AoA I.

Why AoAs?

AoAs help justify the need for starting, stopping, or continuing an acquisition program. They are done because decision-makers need reliable, objective assessments of the options for meeting mission needs. AoAs identify potentially viable solutions and provide comparative cost-effectiveness assessments of each solution to a baseline; this baseline is typically the current systems and their funded improvements.

AoAs are a big factor in selecting a final solution, but they aren't the only factor. The final decision must consider not only cost-effectiveness and military worth, but also domestic policy, foreign policy, technological maturity of the solution, the environment, the budget, and a host of additional factors. AoAs also provide a foundation for developing operational requirements, concepts of operational employment, a test and evaluation plan for the preferred alternative(s), and much additional information of in-

terest to a program office when one is formed.

Who Looks at AoAs

AoAs influence the investment of large sums of defense funds. As a result, they receive multi-layered direction and oversight from start to finish. This direction and oversight is a necessary to achieve a credible AoA and subsequent buy-in of the results. AoA results are usually briefed at high levels in the Air Force and the DoD.

The AoA Study Team

A study director leads the study team performing the AoA. The director is appointed from the Air Force Command (operational user) designated as the lead for that AoA. The study director forms the study team—as appropriate—from members of the Command, other Air Force commands, the Army and Navy, civilian government agencies, and contractors. The study team is organized along functional lines to consider identification of alternatives, threats and scenarios, effectiveness, and cost.

The Air Force Materiel Command (AFMC) Office of Aerospace Studies (OAS) helps by supplying an assistant to the study director who offers help in planning, administering, executing, and facilitating the AoA and its reviews. OAS is the designated Air Force AoA Center of Expertise (COE).

Comparing Alternatives

An AoA compares alternatives by estimating their ability to satisfy the identified mission needs through an effectiveness analysis and by estimating their life cycle costs (LCC) through a cost analysis. The results of these two analyses are used together to produce a cost-effectiveness comparison that allows decision-makers to assess cost and effectiveness simultaneously.

The effectiveness analysis is built on a hierarchy of

- Broad mission tasks (MTs) derived from the mission needs (e.g., kill tanks)
- Measures of effectiveness (MOEs) indicating how well the mission tasks are performed (e.g., weapons expended for each tank killed)
- Measures of performance (MOPs) describing fundamental capabilities (e.g., weapon delivery error)

The life cycle cost analysis estimates how much each alternative will cost to develop, produce, and operate during its lifetime.

Both effectiveness and cost analyses can be lengthy and require a significant investment of resources.

Modeling and Simulation

In the course of performing the effectiveness analysis to evaluate the MOEs, it may be necessary to model each alternative, friendly and hostile forces, the environment, etc. in computer models and simulations (M&S). The planning and execution of this M&S can be difficult, costly, and time-consuming. In most AoAs, this effectiveness modeling is the dominant activity—so much so that the cost and duration of the AoA are largely driven by the complexity and magnitude of the effectiveness analysis. The second most demanding activity in the AoA is usually the cost analysis. Experienced leaders in both of these areas are essential.

AoA Products

Most AoAs produce four major products:

- A study plan which defines the background, goals, methodology, tools, schedule, etc. of the AoA

- A midterm progress briefing to summarize early work and future plans
- A final briefing to summarize the final results of the AoA
- A final report to document the AoA in detail

The study plan is important because it defines what will be accomplished and how it will be accomplished. The plan should be updated throughout the AoA as changes in threat, computer models, methodology, etc. occur. The midterm briefing is designed to permit redirection of the AoA by senior reviewers if necessary. The final briefing will carry the most impact, and hence will generate the most interest. The final report is the repository for AoA information and will require significant effort to produce. Frequently, the study plan or final report will be accompanied by supporting documents providing detailed descriptions of the alternatives, threats, cost documentation, intermediate analysis results, and so forth.

2 Overview of the Acquisition Process

Acquisition programs and AoAs have roots in the Air Force Mission Area Planning (MAP) process. The recurring MAP process is conducted by Air Force Major Commands (MAJCOMs) and consists of three steps:

- Mission Area Assessment (MAA) to convert national strategies to Air Force tasks (strategies-to-task)
- Mission Need Analysis (MNA) to identify deficiencies of the current force to perform the identified tasks (tasks-to-needs)
- Mission Solution Analysis (MSA) to identify possible remedies for the deficiencies (needs-to-solutions)

A MAJCOM's first choice to resolve a deficiency is to identify a non-materiel solution due to the relative low cost. Such solutions could be a change in organization, doctrine, tactics, or additional/modified training.

Once the MAJCOM determines that a materiel solution is required (something must be bought) it generates a Mission Need Statement (MNS). The MNS documents the deficiencies in terms of operational capabilities. A MNS is called validated when the appropriate higher decision authority approves it.

A validated MNS may or may not lead to a Milestone 0 decision (a decision to begin the acquisition cycle) depending on service, DoD or national priorities. A Milestone 0 decision will lead to Phase 0 of the cycle and an AoA I.

Figure 2-1 shows the process from MAA to AoA I.

The Acquisition Cycle

The Acquisition Cycle consists of four milestones (decision points) and four corresponding phases that span the life cycle of a weapon system. These milestones and phases are shown in Figure 2-2.

Acquisition Phases

A milestone (MS) precedes each phase and represents the point in the cycle at which the designated Milestone Decision Authority (MDA) considers the future of the program: concept development at MS 0, program initiation at MS I, and program advancement (or cancellation) at later milestones.

The Acquisition Program Baseline (APB), Operational Requirements Document (ORD), and Test and Evaluation Master Plan (TEMP)—all discussed later in this chapter—are updated and approved at each milestone, and goals

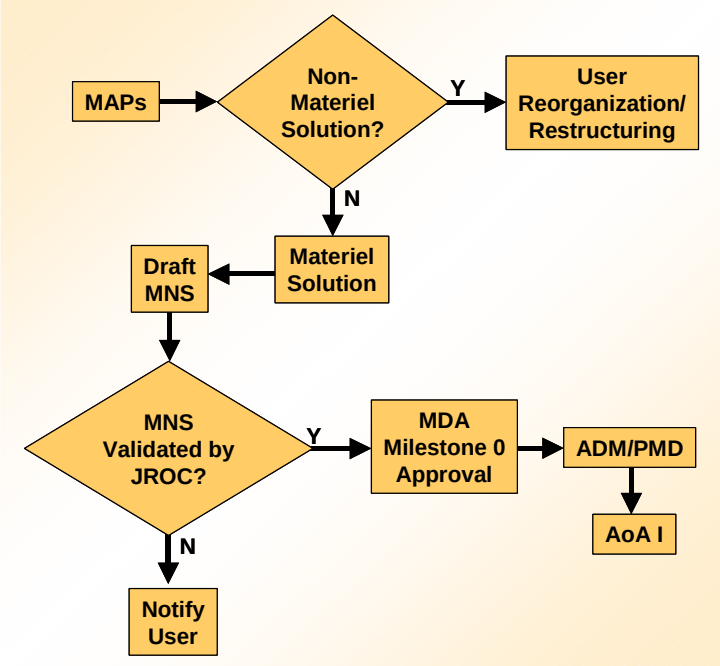

Figure 2-1 : Path from Recognition of Mission Need to AoA I

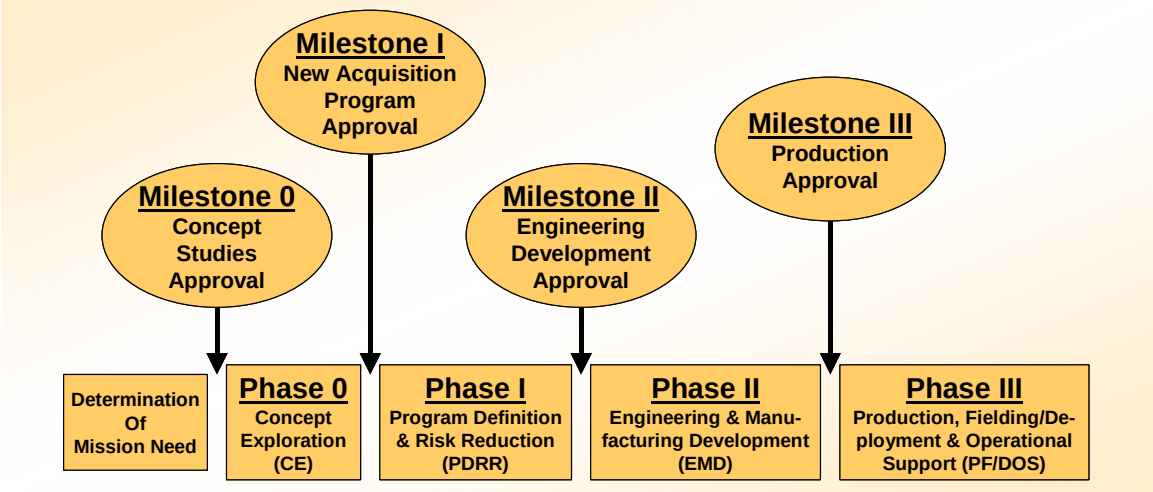

Figure 2-2 : The Acquisition Cycle

(exit criteria) are established that the program must meet in order to reach the next milestone.

Thus, before Milestone II can occur, the performance in Phase I must satisfy the exit criteria developed at MS I. Milestone decisions are documented in an Acquisition Decision Memorandum (ADM).

Phase 0: Concept Exploration

During Concept Exploration, the lead agency conducts effectiveness studies of alternative concepts and develops preliminary life cycle cost (LCC) estimates for each alternative. These studies consider factors such as alternate design concepts, system producibility, Initial Operating Capability (IOC), and logistics support. The acquisition strategy and concept baselines are developed in Phase 0 to support the MS I decision. This phase is generally short (one to two years) and costs relatively little.

Phase I: Program Definition & Risk Reduction (PDRR)

The objective of PDRR is to analyze different technology configurations for the preferred alternative(s) identified in Phase 0 and to reduce technical risk. Typical activities include prototype development, developmental test and evaluation (DT&E), technical reviews, and identification of potential environmental consequences. The acquisition strategy and development baseline are refined in Phase I to support the MS II decision process. Phase I typically lasts two to three years, but it can stretch to as many as five years for high-cost, high-risk programs that involve prototype development (e.g., F-22).

Phase II: Engineering and Manufacturing Development (EMD)

EMD is focused on maturing the system design into a producible, cost-effective system. Testing receives heavy emphasis. DT&E is conducted to ensure specifications are met, and Operational Test and Evaluation (OT&E) is conducted to ensure the system is operationally effective and suitable. During Phase II, the acquisition strategy is further refined, the production baseline is defined, and the support plan is completed. This phase usually lasts between four and seven years and is often very costly.

Phase III: Production, Fielding/Deployment, & Operational Support (PF/DOS)

The system is produced and delivered (along with the supporting infrastructure) to the end user during Phase III. The objective of PF/DOS is to establish a safe, efficient production and support base; achieve an operational capability that satisfies the mission; and ensure the system continues to provide capabilities required to meet the mission need. Typical activities include monitoring system performance and readiness, identifying and correcting system deficiencies to improve performance and supportability, conducting follow-on OT&E, monitoring environmental impact, and preparation for disposal. Support continues throughout the system life cycle.

Major Modification Approval

During Phase III, the MDA may de-

Table 2-1 : Acquisition Categories

ACAT	Remarks	Inclusion Criteria*	Review Level	MDA
ID	Major Defense Acquisition Program (MDAP)	Designated by USD(A&T) *or* RDT&E >$355M *or* Procurement >$2.135B	Defense Acquisition Board (DAB)	USD(A&T) (DAE)
IC	Major Defense Acquisition Program (MDAP)	Designated by USD(A&T) *or* RDT&E >$355M *or* Procurement >$2.135B	Service HQ	Service Acquisition Executive (SAE)
IAM	Major Automated Information System Acquisition Program (MAISAP)	Designated by ASD(C3I) *or* any year's program cost >$30M *or* Total Program cost >$120M *or* Life cycle cost >$360M		OSD Chief Information Officer (CIO)
IAC	Major Automated Information System Acquisition Program (MAISAP)	Designated by ASD(C3I) *or* any year's program cost >$30M *or* Total Program cost >$120M *or* Life cycle cost >$360M		DoD Component Chief Information Officer (CIO)
II	Major Program not meeting criteria for ACAT I	Designated by DOD Component Head *or* $140M RDT&E *or* $645M Procurement	Service HQ	Service Acquisition Executive (SAE)
III	Program not meeting criteria for ACAT I or II	Not ACAT I or II	Lowest Appropriate Level	Lowest Appropriate Level

*Amounts in constant FY1996 dollars

termine if major modifications are warranted to a system still in production. Unmet thresholds, new technology, a reevaluated threat, or a late-developing requirement may prompt these changes. Approval may return a program to an earlier phase of the acquisition cycle, depending on the technical complexities of the modification being considered.

Acquisition Categories (ACAT)

Weapons system programs and Command, Control, Communications, and Intelligence (C3I) system programs are placed in ACATs based on the dollar value and level of decision authority. These categories were established to facilitate decentralized decision making, yet still comply with Congressional mandates for appropriate oversight. The categories, the criteria that establish them, and their oversight levels are shown in Table 2-1.

ACAT I

ACAT ID and ACAT IC programs are known as Major Defense Acquisition Programs (MDAP). ACAT ID and IC programs must meet one of two cost thresholds: at least $355 million in Research, Development, Test, and Evaluation (RDT&E); or $2.135 billion in procurement (both in constant FY96 dollars). The level of decision authority further differentiates these programs.

ACAT ID programs are approved at the DoD level by the Undersecretary of Defense for Acquisition and Technology [USD(A&T)], also called the Defense Acquisition Executive (DAE).

ACAT IC programs are approved at the service level. This approval comes from either the service secretary or, more usually for the Air Force, by the Assistant Secretary for Acquisition (SAF/AQ), who is the Air Force Service Acquisition Executive (SAE).

The SAE and DAE can elevate the ACAT level of any program to reflect its visibility and/or importance. Thus, a program that does not meet the dollar thresholds, but has high congressional interest, may be established as an ACAT ID or IC program by the decision authority.

ACAT IA (IAM and IAC) programs are called Major Automated Information System Acquisition Programs (MAISAP). They must meet the dollar thresholds given in Table 2-1. The MDA for IAM programs is the Office of the Secretary of Defense (OSD) Chief

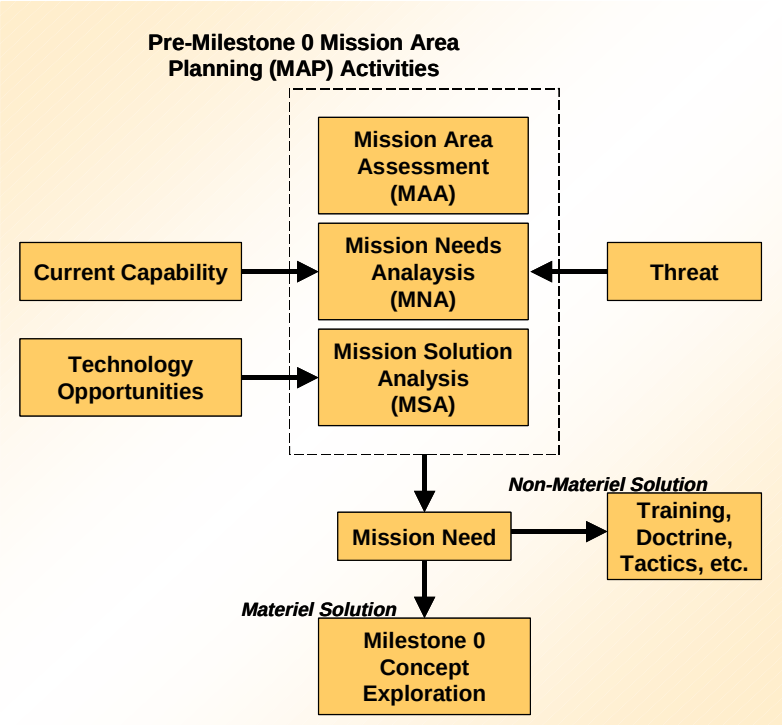

Figure 2-3 : Pre-Milestone 0 Activities

Information Officer (CIO). The MDA for IAC programs is the DoD Component Chief Information Officer (CIO).

ACAT II

ACAT II programs fall below ACAT I dollar thresholds, but require at least $140 million in RDT&E or $645 million in procurement funds (both in constant FY96 dollars). The decision authority is at the DoD Component Acquisition Executive (CAE) level (in the case of the Air Force, the AF SAE).

ACAT III

ACAT III programs fall below ACAT II dollar thresholds and are approved at the lowest appropriate level. This could be at the component level or at the component's Program Executive Office (PEO). Within the Air Force, that authority usually resides within AFMC.

AoA Activities

Pre-Milestone 0 Activities

The Pre-MS 0 activities—MAA, MNA and MSA—precede the AoA and are the foundation for the AoA I. These activities form the mission area planning (MAP) process and are the responsibility of the operating command. The AoA I should exploit MAP results, including identification of needs, possible alternative solutions, and supporting analyses.

The Pre-MS 0 identification of needs is illustrated in Figure 2-3. The needs may come from a variety of sources within or outside the operating command. Deficiencies that can be satisfied by non-materiel changes in doctrine, tactics, training, or organization are sent to the military department for consideration and action. Deficiencies that could result in the establishment of a new acquisition program (materiel solutions) are documented along with the concept of operations and the threat in a MNS. The

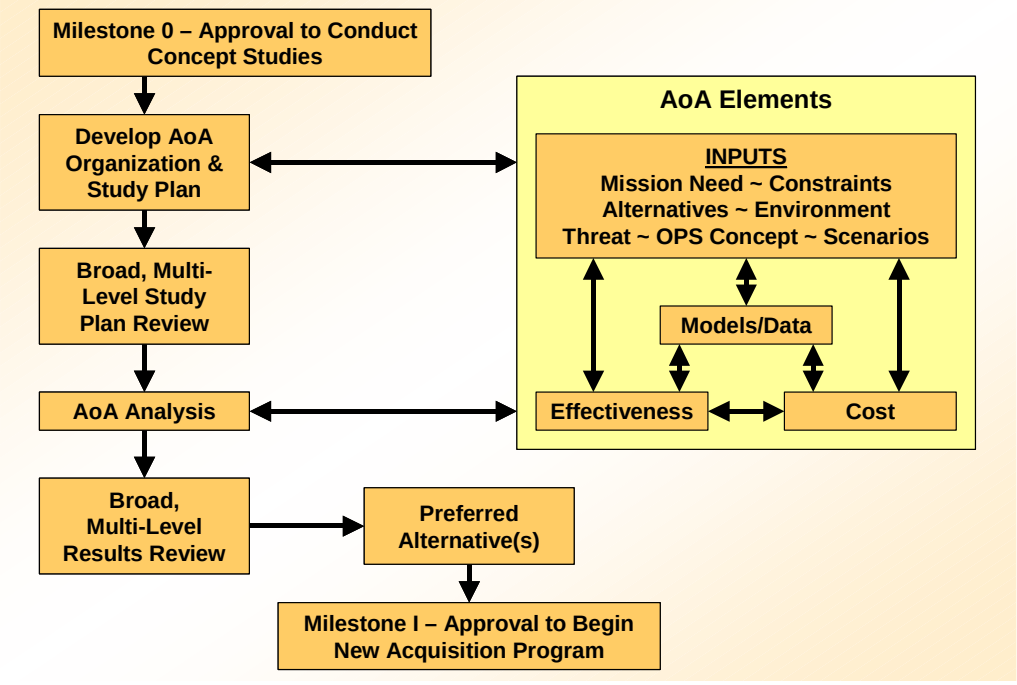

Figure 2-4 : Phase 0 AoA Activities

process may then proceed to a MS 0 decision.

Phase 0 Activities

The AoA I (there is no AoA 0) is the focus of Phase 0. The AoA I is designed to examine a broad spectrum of potential alternatives to the mission need described in the MNS. The AoA I may be service-specific or joint. Air Force-specific AoAs are usually lead by a MAJCOM specified in the ADM. Joint AoAs are led by an ADM-designated lead service.

The AoA I identifies one or more promising alternatives to the MDA for further development, based on cost and effectiveness. A general representation of AoA I activities is illustrated in Figure 2-4. The left side of the figure depicts the general AoA process of preparing a plan, performing the analysis, and reviewing the results. The right side depicts elements that are essential to AoA development. Double-headed arrows represent interdependencies among the elements in the diagram. The analyses that are conducted during this phase support the MS I decision and are detailed in an AoA I report.

Each of the AoA activities and elements illustrated in Figure 2-4 will be discussed in more detail later in this handbook.

The Phase 0 analysis provides the foundation for developing the Operational Requirements Document (ORD), Test and Evaluation Master Plan (TEMP), System Threat Assessment Report (STAR), acquisition strategy, and program plans (discussed later in this chapter).

An AoA I, like all AoAs, may be tailored to address MDA concerns. Tailoring can take many forms, including expanding or contracting the scope or depth of the AoA analysis and modifying its focus.

Phase I Activities

Phase I begins the program development effort. Requirements, test, and program documents are updated to reflect what was learned during early system design and demonstration efforts. The AoA study plan is updated for the Phase I analysis to reflect the current issues from the MDA.

This AoA (designated AoA II) can be much more detailed than an AoA I

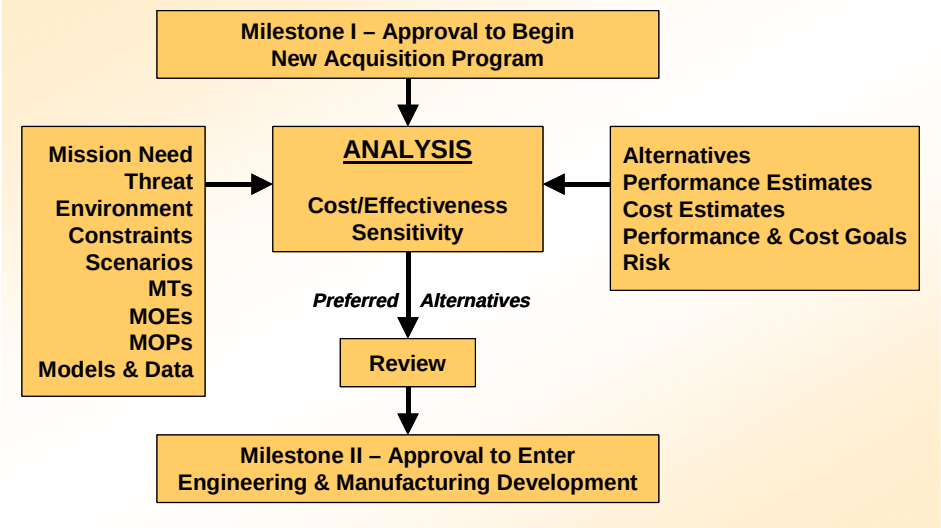

Figure 2-5 : Phase I AoA Activities

because there are only one or two alternatives to consider. There is usually a preferred alternative that can be described with more confidence in terms of cost and performance. The demonstration and validation tests performed on the alternatives will provide useful data for the analysis. Figure 2-5 shows the activities in this phase.

The AoA II analysis should revisit the go/no-go question, making use of the better alternative definitions and any new information. Assuming that the acquisition proceeds, the goal of this AoA is to identify the preferred system implementation. Sensitivity analyses should quantify the impact on cost effectiveness of uncertainties in cost, performance, supportability, and schedule. The analysis should identify cost ceilings and performance floors.

Table 2-2 highlights the differences between AoA I and AoA II activities. The hardware alternatives in Phase I typically represent a narrower range, with more information and definition. The additional information should permit much better cost and performance estimates than possible in Phase 0.

Phase II and Phase III Activities

Figure 2-6 illustrates the activities in Phases II and III.

The decision authority may require an AoA update before MS III to account for any factors that may have changed during the preceding phase. When the AoA II sensitivity analyses have adequately addressed the impact of changes in significant factors (cost, performance, schedule, threat), the MDA should be asked to waive an AoA III.

When a new system or a major modification to a system in Phase III (production) is required, the decision authority may require a new AoA. This AoA will be an AoA I, essentially returning the program to Phase 0.

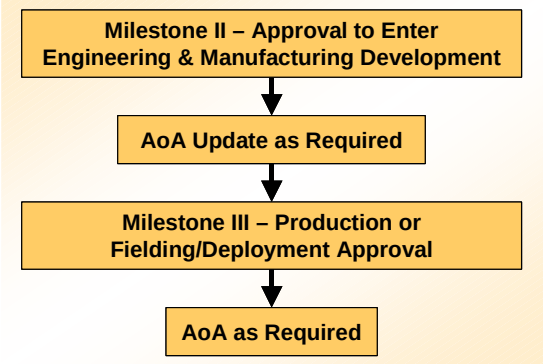

Figure 2-6 : Phases II and II AoA Activities

Table 2-2 : Comparison of AoA I and AoA II Activities

Element	Phase 0 (AoA I)	Phase I (AoA II)*
Mission need	Confirm	Update
Threat	Characterize	Update
Scenarios	Develop	Update
Operating environment	Characterize	Update
Constraints & assumptions	Identify	Update
Operations concept	Develop	Update
Description of alternatives	Develop	Refine/focus
Mission tasks	Identify	Update
MOEs/MOPs	Develop	Update
Models & data	Identify/develop	Update
Life cycle cost	Perfrom	Refine
Analysis	Perform	Perform
Report	Prepare	Prepare

*Column also describes the nature of Phase II (AoA III) activities

AoA-Related Documentation

The acquisition cycle generates a number of documents related to AoAs. One, the MNS, has already been discussed. This section expands on that

discussion and introduces other documentation important to AoAs.

Mission Need Statement

A MNS may be prepared by any DoD component (Air Force, Army, Navy or Marines) which has identified a specific mission area need or deficiency. The MNS identifies the need to establish a new operational capability, improve existing capabilities, or exploit an opportunity that cannot be satisfied with non-materiel solutions. It applies to all materiel acquisition programs, not just major programs, and is developed by major operating commands.

For potential major defense ACAT I programs, the MNS is sent to the Joint Requirements Oversight Council (JROC) for validation. Submission to the JROC is the first step in program initiation. The MNS is then submitted to the USD(A&T) for Defense Acquisition Board (DAB) review and approval to proceed with concept evaluation studies in Phase 0. MS 0 decisions are documented in an ADM.

The MDA for a non-ACAT I MNS is the DoD CAE, or the lowest level deemed appropriate by the DoD CAE.

Operational Requirements Document (ORD) and Requirements Correlation Matrix (RCM)

The ORD replaces all service unique documents [e.g., Statement of Operational Need (SON), Tentative Operational Requirement (TOR), Required Operational Capability (ROC), etc.]. It addresses performance and related operational parameters of the proposed system or concept and discusses how the system will be operated, deployed, employed, and supported. It provides initial guidance for the implementing, supporting, and participating commands and agencies.

The ORD is prepared during Phase 0 by the user, approved by the service chief, and submitted at MS I to the JROC. At the beginning of Milestone I, the JROC reviews the ORD and the Acquisition Program Baseline (APB).

The ORD will be updated and expanded for MS II and will only be modified thereafter 1) if there is a significant change in the MNS, or 2) as a result of cost-schedule-performance tradeoffs performed during Phase II. The ORD is used to develop requirements for contract specifications during each acquisition phase.

The Requirements Correlation Matrix (RCM) is a three-part matrix attached to the ORD and is used to provide a system audit trail of the capabilities and characteristics identified in the ORD. It lists user-identified system capabilities and characteristics with accompanying thresholds and objectives, identifies user-recommended key performance parameters, and provides supporting rationale for justifying each threshold level and any changes in requirements that may occur as the system matures.

System Threat Assessment Report (STAR)

Threat Assessment Report (TAR) for Air Force component programs or Threat Planning Document (TPD) for PEO programs is the key threat document supporting milestone reviews and program management. The intelligence office of the implementing command initially prepares the STAR at MS I. The Defense Intelligence Agency (DIA) or the Assistant Chief of Staff for Intelligence (AF/IN) then validates the document. The STAR, TAR, or TPD

becomes the primary document for current, projected, and reactive threats against the system.

Additional information on these documents is contained in AFR 200–13, Threat Support to the Weapon System Acquisition Process.

The Test and Evaluation Master Plan (TEMP)

The TEMP identifies and integrates the overall structure and objectives of the test and evaluation program. It also identifies responsibilities, resources, and schedules to be accomplished prior to future milestone decision points.

The draft TEMP is submitted 45 days prior to MS I DAB reviews for ACAT ID and IC programs or within 90 days for programs designated less than ACAT I. It is updated at each milestone.

The TEMP is prepared by the System Program Director (SPD) and validated by the CAE and OSD prior to submittal to the USD(A&T).

Single Acquisition Master Plan (SAMP)

The SAMP is a comprehensive Air Force-unique plan which discusses all relevant aspects of a program. Written at the strategic level, the SAMP meets the program oversight and statutory requirements contained in other management plans such as the TEMP, the Integrated Logistics Support Plan (ILSP), etc.

Acquisition Program Baseline (APB)

The APB describes what will be

Table 2-3 : Cost Documents

Document Name	Description	Responsibility	Timing
Cost Analysis Requirement Description (CARD)	The CARD identifies & quantitatively describes system characteristics, establishing the basis for cost estimates	Prepared by the technical staff of the program office	Draft CARD provided 180 days prior to being reviewed by the Overarching Integrated Prduct Team (OIPT); final CARD submitted 45 days prior to OIPT
Program Office Estimate (POE)	Program life cycle cost (LCC) estimate based on CARD; updated to reflect SCP	Prepared by the program office	Draft documentation provided 45 days prior to being reviewed by the OIPT; final estimate 21 days prior to OIPT
Independent Cost Estimate (ICE)	For MS I-III, LCC estimate for all ACAT ID programs and ACAT IC as requested by USD(A&T)	OSD Cost Analysis Improvement Group (CAIG)	After MS 0 and at each MS review thereafter
Component Cost Analysis (CCA)	May be full independent estimate or tailored for high risk/high cost items	Air Force Cost Analysis Agency (AFCAA); AF CAIG reviews and approves	Draft documentation provided 45 days prior to being reviewed by the OIPT; final estimate 21 days prior to OIPT
Service Cost Position (SCP)	Reconciliation of POE and CCA estimates	Draft SCP developed by the Cost IPT; final SCP prepared by the AF CAIG	Briefed to OSD CAIG 21 days prior to OIPT; full documentation provided 10 days prior to OIPT

done, when it will be done, and at what cost. It establishes a commitment among the Program Director, PEO, and the CAE and serves as the basis for accountability of the Program Director and PEO.

Cost Documents

A summary of cost-related documents is contained in Table 2-3.

Acquisition Cycle Exceptions

Acquisition Streamlining

The Federal Acquisition Streamlining Act (FASA) of 1994 ushered in changes in acquisition regulations; these changes are often referred to as "acquisition reform."

For programs designated as streamlined acquisition programs, FASA provides DoD authority to use commercial practices in acquisition programs. Often these practices result in fewer government "specs" and decrease the overall cost of the weapon system.

Streamlined programs are characterized by their short duration and use of a "rolling down-select" concept which starts with many competitors, down-selects to two, then finally to one.

By their nature, streamlined acquisition programs can go from Pre-MS 0 to initial operationally capability (IOC) in as little as six years. These programs often use competition in the down-select process to reduce risk and to lower program cost.

Advanced Concept Technology Demonstrations (ACTD)

The ACTD is an effort to assemble and demonstrate a significant new military capability based on maturing technologies in a real-time operation at a scale adequate to clearly establish operational utility and system integrity.

A major benefit of an ACTD is the ability to field an operational capability much faster than current (non-streamlined) acquisition processes. ACTD programs are required to demonstrate and field a new capability in two to four years. A warfighting sponsor accepts the capability in their command as an ACTD "leave-behind" or "residual." Although usually fielded in small numbers (i.e., fielded prototypes), these residual items can be complex in nature and may require significant intelligence infrastructure integration.

Successful ACTDs frequently enter the mainstream acquisition process at an appropriate milestone for further development and fielding.

3 AoA Structure & Interacting Organizations

An AoA is conducted by a working group (WG) led by a director and staffed appropriately, usually by a diverse group of government and contractor personnel. This working group is referred to as a study team. Throughout the AoA the study team will interact with individuals and groups that provide assistance and direction. This chapter discusses study group composition, responsible parties, and the names and roles of companion players.

Study Team Structure

Study Team Director

The lead operating command for the AoA appoints an AoA study team director to lead the AoA. The AoA directorship is a full-time job benefiting from mature leadership skills and continuity of service. Ideally, the study director is a major or lieutenant colonel (or civilian equivalent) from the lead command. Typically, a deputy from the same command supports the director, along with experienced analysts to lead the effectiveness and cost analysis processes. OAS provides an assistant to the director. The assistant's responsibilities are to provide procedural guidance for AoAs and to serve the director in whatever capacity required to ensure a quality AoA.

Study Team

Guided by a high-level Overarching Integrated Product Team (OIPT) and working-level IPTs, the director establishes the study team to plan and execute the AoA. Study team membership is determined by the needs of the AoA, and members with appropriate skills are usually drawn from the organizations identified in Figure 3-1. This often includes

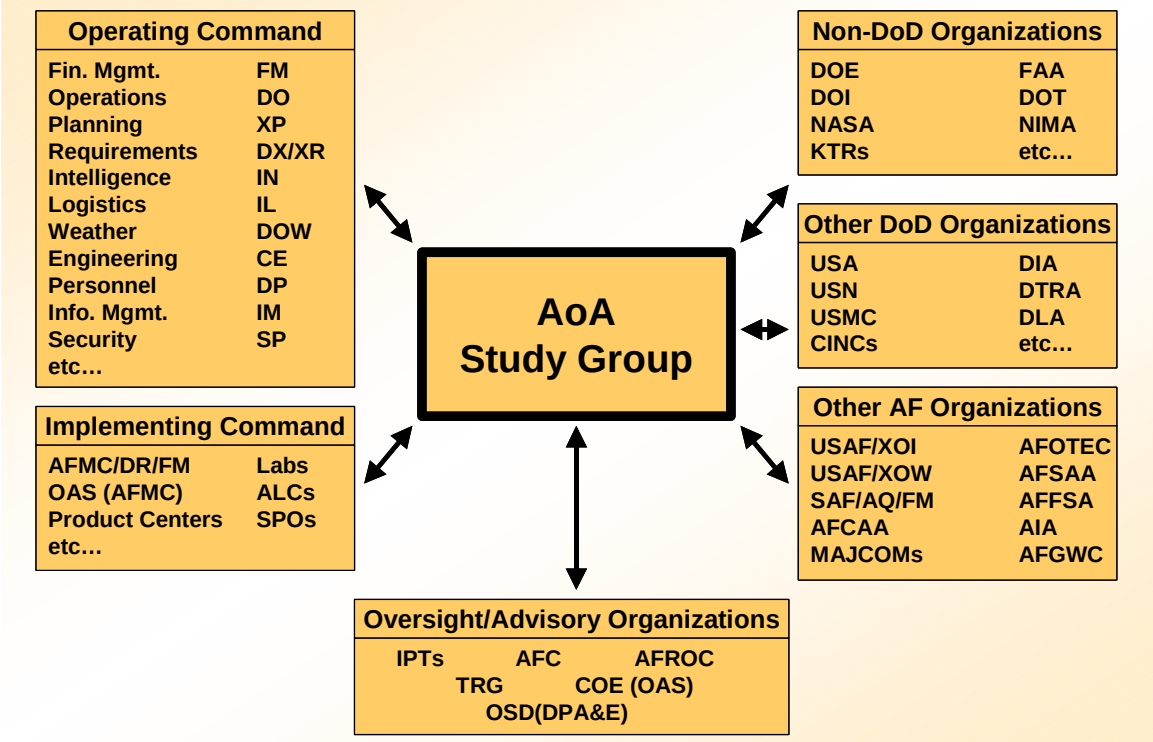

Figure 3-1 : Typical Organizations Supporting the AoA Working Group

contractors who provide critical skills and resources. The team focuses on defining alternatives, then assessing and comparing their operational effectiveness and life cycle costs.

The study team is generally organized along functional lines into panels with a chair for each panel. Typical functional areas for the panels are threat and scenarios, technology and alternatives (responsible for defining the alternatives), operations concepts (of the alternatives), effectiveness analysis, and cost analysis. While the work of all the panels is vital to the AoA, the effectiveness analysis panel—chief integrator of the work of the other panels—occupies the pivotal position.

The structure of a typical study team showing panels and various players is provided in Figure 3-2. While other panel structures may be more appropriate to a particular AoA, the use of functionally oriented panels has been used successfully for years to perform large, complex studies.

The panels meet separately to address their fundamental issues. They also meet in conjunction with other panels or the study team as a whole to exchange information. Frequent and open exchange of ideas and data is key to a successful AoA. The importance of this is greatest when the team is geographically dispersed—a common happenstance.

Open communication is enhanced by documenting questions, answers, and decisions made in the various panels. This can be done through taking and distributing minutes of panel meetings. Frequent interaction via telephone and e-mail at all levels should also take place.

Another key to success is keeping the AoA study team intact throughout the AoA. A changing membership diminishes the corporate memory and creates delays as new personnel are inte-

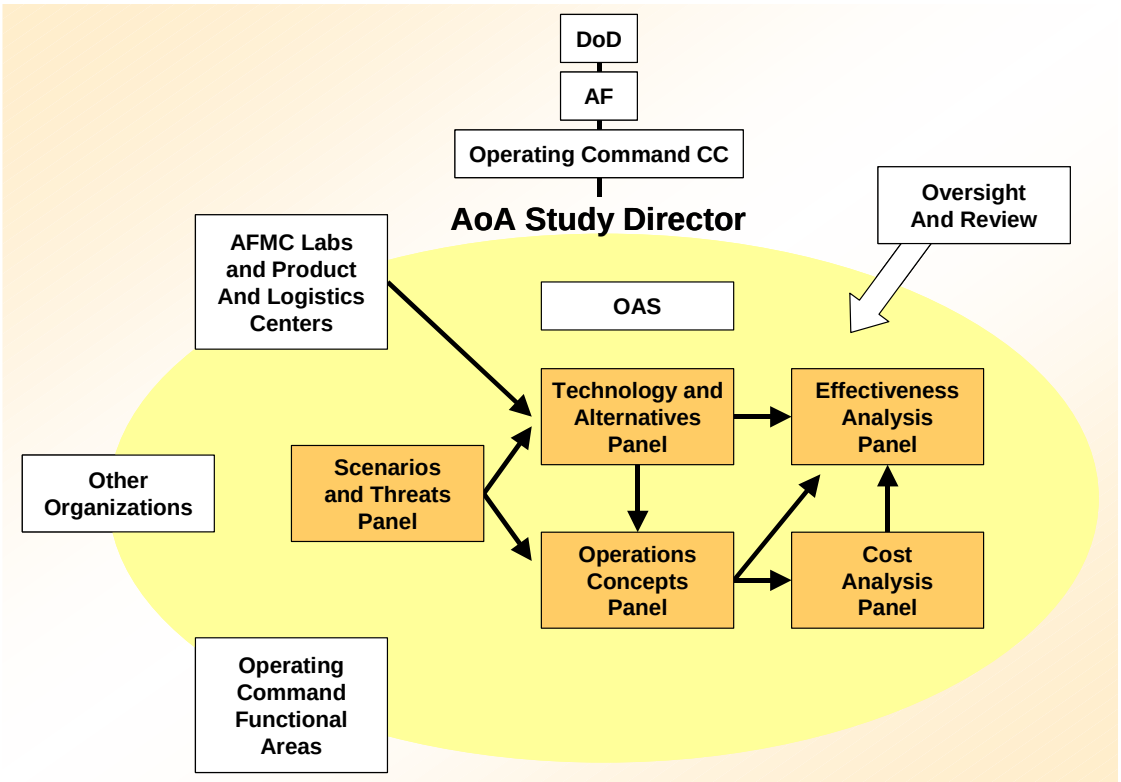

Figure 3-2 : A Typical Study Team Panel Structure with Interacting Organizations

integrated into the effort.

A suggested division of responsibilities between the study team and the supporting organizations is shown in Table 3-1.

Table 3-1 : Typical AoA Study Team Support and Division of Responsibilities

Action	Lead	Support	Remarks
Appoint AoA study team director	Operating command (OC) CC	N/A	Lead operating command designates appropriate directorate (plans, operations, requirements) to provide director; OAS provides assistant to director
Develop AoA study plan	AoA study team director	AoA study team	Director coordinates efforts of study team in developing AoA study plan
Define operations concepts	OC DO or DR	OC XP and IN	
Develop threat and scenarios	OC IN	DIA; USAF/IN; AIA	
Identify and define critical environmental factors	OC DO (or DR) and WE	Implementing command (IC) WE	Weather staff officers from both the operating command and AFMC provide assistance
Environmental impacts	OC CE	OC SG; IC CE and SG	The OC identifies key environmental compliance requirements and pollution prevention issues, supported by the Surgeon General's (SG) office; all proposed projects must be evaluated using the environmental impact process in AFR 19-2
Determine constraints and assumptions	OC XP (or DR) and FM	OC DO; IC DR and FM; AFSAA; AFCAA	
Identify mission tasks	OC DO, DR), XP	OC DO, DR, XP; AFSAA	The OC's DO or DR leads; AFSAA, supported by OAS and AFOTEC, may also provide support
Develop MOEs and MOPs	OC DO, XP, DR	OC DO, XP, DR; AFSAA; OAS; AFOTEC	Either the OC's DO, XP, or DR leads
Identify and develop logistics issues	OC LG (or DR)	OC LG, DR, DO; IC LG	The OC leads work on supportability and maintainability issues
Develop alternatives	AoA study director	OC XP (or DR); IC DR	The appropriate AFMC FM or DR directorate should coordinate inputs from AFMC centers and labs
Select and develop models	OC operation analysts	IC DR and FM; AFSAA; AFCAA; OAS	If the OC doesn't have an operational analysis group, AFMC DR may provide support
Conduct effectiveness analysis and integrate cost analysis	AoA study director	AoA study team; OC DO, DR, FM, and operations analysts; IC DR and FM; AFSAA; AFCAA	The study director, team members, and OC analysts determine who conducts the analysis; for AoAs involving AFMC, DR or FM acts as POC for Phase 0 (drawing inputs from centers and labs); for Phase I and beyond, the appropriate AFMC center is POC; OAS may help OCs without analytical organizations
Conduct cost analysis	OC FM	IC FM; OAS	IC provides acquisition cost estimates for development and production of concepts (including modification costs); for AoAs involving AFMC, the FM shop is the POC; both the OC and AFMC provide the O&S cost estimates; AFMC Human Systems Center (HSC) assists with O&S cost estimates in manpower, personnel, training, and safety (MPTS) for new or upgraded systems; OAS may also provide support; when foreign military materiel are included as alternatives, AFMC's product center(s) provide costing assistance
Write final report	AoA study director	AoA study group; support organizations	

AoA Oversight and Review

AoAs are subject to substantial oversight and review because of their importance. The AoA supports program decisions at the OIPT and Defense Acquisition Board (DAB) level. Integrated product teams (IPTs) perform much of the oversight. For ACAT ID and ACAT IAM programs, there are the OIPTs and one or more working-level IPTs (WIPTs). The Cost Performance IPT (CPIPT) is perhaps the most important from an AoA oversight and review perspective.

An AoA will have many opportunities for review of the study plan, findings, and results. Figure 3-3 identifies steps followed to obtain the review and oversight appropriate for the AoA. Each step is numbered and described below:

Step 1. The study team originates 1) the AoA study plan, 2) mid-term results, and 3) final analysis results. These items must flow through the oversight and review process, along with any status and program updates that may be asked for outside the normal review and oversight.

Since the study team is the source of any original AoA information, the study team is the starting place for the oversight and review process. The complete study team should be involved in developing all of the material that is presented to outside organizations.

Step 2. The coordination, review and oversight process relies on outside functional experts for unbiased constructive evaluation and recommendations to correct and revise the AoA material. Both OAS and the operating command financial management evaluations shown in this step are critical to ensure quality and consistency in the AoA study plan, midterm, and final results.

OAS is focused on the overall quality of the cost and effectiveness analysis and the clarity and soundness of the results and findings of the study. To accomplish this, OAS supports the MAJCOM's development of the study plan, briefings, and the final report.

The MAJCOM financial management specialists are concerned in this step with the appropriateness of the cost

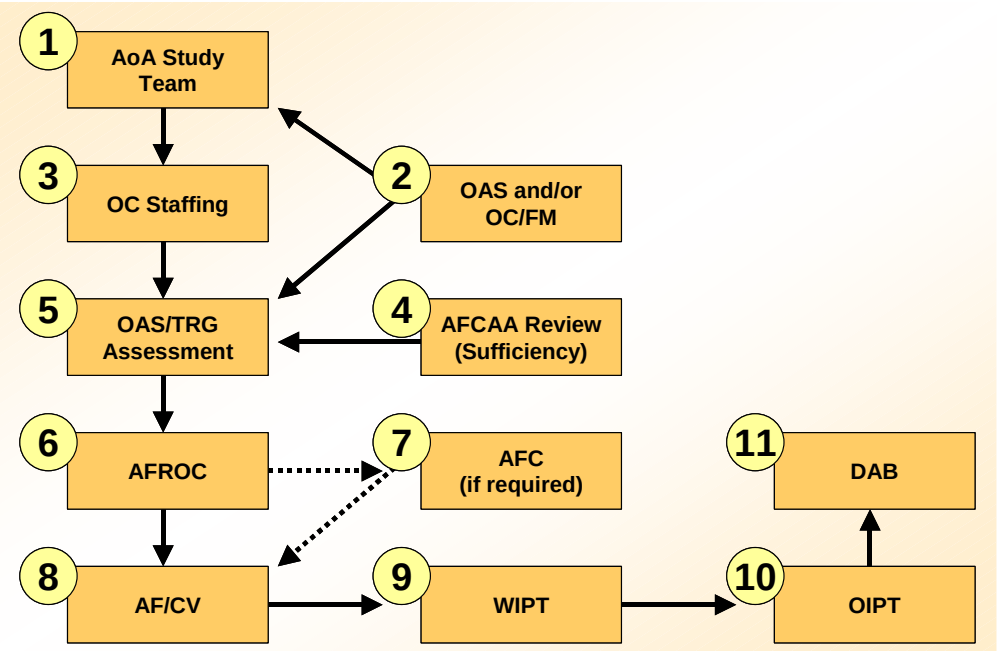

Figure 3-3 : USAF AoA Oversight and Review Process

estimates developed for each of the alternatives in the AoA. Because the AoA is executed by the MAJCOM, it is critical that the AoA address the concerns of the MAJCOM, a command that may ultimately have to use the final system in the field.

Step 2 is also the handoff point of the cost estimates from the operating command to the Air Force Cost Analysis Agency (AFCAA) for sufficiency reviews of each estimate. This step also presents an opportunity to work out potential disconnects for the information being developed and reviewed in steps 4 and 5.

Step 3. This is the starting place for the formal coordination and review process. Once a quality product is available from the AoA study team based on actions completed in steps 2 and 4, the staff of the operating command will review and coordinate on the study plan or the results briefing. This ensures that any operating command concerns about the study have been addressed before being passed to the next level.

Step 4. This step focuses on the cost aspect of AoAs. A significant effort is undertaken to ensure the quality and consistency of the ACAT I cost estimates contained within the AoA. To accomplish this end, the AFCAA will complete a sufficiency review of the cost estimates. These estimates are normally made for each alternative considered within the AoA. AFCAA will also evaluate the data and specific techniques and methodologies being used.

Step 5. In this step, the study director can call a Technical Review Group (TRG) of technical experts, if desired. In most cases OAS analysts are used to assess the quality and consistency of the study plan or the quality of the results being briefed. In any case, consideration is based on established standards for the study plan and the results of the study.

Step 6. This is the step where corporate oversight and review really begins. At this point the study plan, midterm, and final results are presented to the Air Force Requirements Oversight Council (AFROC) to ensure the quality and focus of the study and that the results are realistic and believable. The AFROC tries to resolve all problems. They also provide interest and support for the potential capability being analyzed and evaluated with the AoA.

Steps 7 & 8. The findings of the AFROC review for the study plan, midterm, or final results are documented and presented to the AF/CV. If there are unresolved issues from the AFROC, the AF/CV may call the Air Force Council (AFC) into session to resolve these issues. Once all remaining issues are resolved, the council provides the results to AF/CV to continue the review and oversight process. At this point the AoA information found in the study plan, midterm, or final results from the AoA can be provided to the acquisition community.

Step 9. The AoA information is provided here to WIPT which needs it to execute the acquisition process. Note that the WIPT may also have helped to focus and provide guidance early in the process to ensure that the study provides the needed analysis to allow decision making for the acquisition of the new system. When the WIPT has received the AoA results, it can direct that the results be presented to the OIPT.

Step 10. In this step, the OIPT receives the AoA information it needs in order to proceed with the acquisition of the program. If the OIPT is happy with the AoA findings and the other information asked for by the MDA, they make a

milestone decision at this point or direct the finding on to step 11, the Defense Acquisition Board (DAB), for the milestone decision.

Step 11. The DAB is the normal system acquisition decision point and AoAs are a major input to those decisions. The MDA listens to all the findings and results, and together with information and recommendations submitted by the MDA staff, makes the acquisition decision for the milestone.

DoD Review

Overarching Integrated Product Team (OIPT)

An OIPT is formed for ACAT ID and ACAT IAM programs to provide assistance, oversight, and review as the program proceeds through its acquisition life cycle. The OIPT for ACAT ID programs is led by the appropriate Office of the Secretary of Defense (OSD) official—typically the Director of Strategic and Tactical Systems, the Assistant Deputy Under Secretary of Defense (ADUSD, Space and Acquisition Management), or the Deputy Assistant Secretary of Defense (DASD, C3I Acquisition). The DASD (C3I Acquisition) designates the OIPT leader for each ACAT IAM program.

The OIPT consists of senior representatives from DOD, principal operating command organizations, implementing and supporting commands, SAF/AQ, SAF/FM, USAF/XO, AFSAA, AFOTEC, and others as required. The OIPT reviews the AoA effort at the following points:

- Completion of AoA study plan
- Completion of AoA final results briefing
- When significant problems or changes arise

Working-Level Integrated Product Teams (WIPTs)

WIPTs are formed to support a particular process or functional area. WIPTs supporting the AoA process may be focused on test, operational requirements, logistics, etc. A WIPT formed to oversee the development of the AoA and other cost/effectiveness issues is generally called a Cost Performance IPT (CPIPT) or an Analysis IPT (AIPT).

Each WIPT consists of mid-level representatives from DOD, principal operating command organizations, implementing and supporting commands, SAF/AQ, SAF/FM, USAF/XO, AFSAA, AFOTEC, and others as required. WIPTs review the AoA at the following points:

- Completion of AoA study plan
- Completion of AoA
- As a result of any changes, updates, or problems related to the AoA effort

The Integrating Integrated Process Team (IIPT) is a special WIPT. The IIPT is not a standing IPT, but one called into being to solve problems common to a number of WIPTs. The membership is composed of the chairs of all the standing WIPTs. The chair of the IIPT is normally taken by one of the WIPTs that has identified the problem.

Air Force Review

Air Force Requirements Oversight Council (AFROC)

The AFROC assists the Chief of Staff Air Force (AF/CC), the Vice Chief of Staff Air Force (AF/CV), and AF/XO in their responsibilities to assess Air Force operational requirements. This includes review and oversight of requirement aspects of the AoA.

The AFROC may recommend that AF/CV approve the study plan, midterm, or final results without going to the Air Force Council (AFC).

The membership of the AFROC consists of senior members from USAF/XOR (chair), SAF/AQ, SAF/FM, AFMC, AFOTEC, AF/XOI, USAF/IL, USAF/XP, USAF/XOF, and USAF/XOC. Ad hoc members include USAF/CE, USAF/SC, USAF/SG, and USAF/SP, the MAJCOM Requirements Principal, and other service representatives as required. Specific functions include:

- Ensure Air Force needs and requirements are being met
- Ensure MNS and ORD are developed to DoD, AF, and JROC standards
- Review all warfighting deficiencies
- Resolve cross-service issues for joint programs
- Ensure consistency throughout the MAA, MNA, MNS, and AoA documents

Air Force Council (AFC)

The AFC is the senior deliberative body of the Air Force. After review and deliberation on key issues, it provides recommendations to the final decision making authorities of the Air Force—Secretary of the Air Force (SAF) and AF/CC.

The purpose of the AFC is to ensure that Air Force AoAs reflect senior leadership consensus on the AoA's analytical foundations before submitting them to the OIPT, the JROC, and OSD. The study team then provides AoA review information to the OIPT, supported by the senior Air Force member. The AFC is convened by the Vice Chief of Staff Air Force (VCSAF) through the Air Force Executive Review Secretariat, AF/CVS. For joint programs (where the Air Force is the lead service) and Special Access Required (SAR) programs, the Special Programs Oversight Council (SPOC) reviews the AoA instead of the AFC.

AF/CVS is solely responsible for coordinating and scheduling briefings for the AFC or SPOC. The AFROC may recommend additional membership for AoA reviews through AF/XOCA to AF/CVS. The AFC is supported by the AFROC and the Technical Review Group (TRG) or COE. Specific AFC functions include:

- Review ACAT I AoAs (and other AoAs as deemed appropriate by AF, OSD, Congress, or the AFC chair); approve study plan and results going to OIPT
- Ensure adequacy and completeness of analysis
- Emphasize consistency of analysis across Air Force AoAs with respect to alternatives, scenarios, assumptions, requirements, etc.
- Recommend changes in direction, additional work, modifications, and acceptance as appropriate to the operating command/CC, Air Force, and/or DOD approval authority

Technical Review

OAS conducts ongoing oversight of the technical adequacy of the AoA through day-to-day participation in the study and through reviews of the study plan, midterm, and final results. At the option of the AoA study director or the AFROC, a TRG may be convened to assess the technical adequacy of the AoA.

The Chief Scientist, HQ USAF, Director of Command and Control (AF/XOC) chairs the TRG. TRG membership consists of senior technical representatives from the MAJCOM, OAS, AFSAA, AFOTEC, AF/XOI, AF/XOR, AF/ILE, SAF/AQX, SAF/FMC, and others as required. AF/XOCA provides the TRG secretariat.

The TRG will normally focus on the draft study plan, midterm, or final study results. Their assessment is provided to the AFROC and Air Force Council.

Interacting Organizations

Program Executive Officer (PEO)

The PEO, in support of the OIPT, provides an early interface between the operational and acquisition communities, facilitates execution of a streamlined acquisition process (when appropriate), provides direction to the IIPT, and provides senior level coordination with the sister services for joint programs. The PEO resolves AFC concerns and problems elevated by the IIPT and may elevate issues to the OIPT.

Air Force AoA Center of Expertise

The AFMC Office of Aerospace Studies (OAS) is the Air Force COE for AoAs. In the absence of a TRG, OAS assesses the AoA for technical adequacy and completeness and provides the AFROC with an evaluation of the AoA product. To support top quality AoAs, OAS may:

- Designate an OAS staff member to serve as assistant to the AoA study team director
- Help obtain Air Force resources from the product centers, logistics centers, laboratories, etc. to support AoA development
- Provide limited analytical support for operational effectiveness and cost analyses
- Assist in writing AoA plans and final reports
- Help obtain and administer funds to initiate the AoA
- Identify potential contractors and contract vehicles
- Project funding needs for future AoAs
- Support policy development as requested by the Air Staff
- Help standardize Air Force AoAs by interpreting guidance and recommending standard practices
- Publish, maintain, and distribute the ***AoA Handbook***
- Develop AoA standards and guidelines in concert with the Air Force analysis community for inclusion in the ***AoA Handbook***
- Provide introductory and follow-on training on AoA development
- Provide technical advice and support to the AoA Study Team on:
  - Procedures
  - Organization
  - Analysis techniques
  - Application of appropriate M&S
- Advise the AoA study team, the oversight IPTs, the AFROC, and the AFC on the findings of any AoA product assessment
- Develop and maintain the Air Force "corporate memory" on AoAs
- Maintain an Air Force library of AoA documents and lessons learned

SAF/AQ

SAF/AQX directs the appropriate SAF/AQ organization to prepare the ADM prior to PMD issuance. AQX and HQ USAF/XOC assist HQ USAF/XOR with the required direction, funding, and tasking necessary for concept studies and AoA preparation. The applicable SAF/AQ mission area director issues and coordinates the implementing PMD which follows MS I. AQX participates on the AoA study team or appropriate IPT as required.

SAF/FMC and AFCAA

SAF/FMC convenes the Air Force Cost Analysis Improvement Group (AFCAIG) and reviews the AoA report as required. SAF/FMC provides policy guidance pertaining to the Air Force cost community and participates on the appropriate IPTs as required. They also provide the Air Force interface with the OSD Cost Analysis Improvement Group (CAIG) on AoA costing issues.

The AFCAA, SAF/FMC's Field Operating Agency, conducts Air Force Component Cost Analyses (CCA) for weapon system and automated information system acquisition programs as required by DoD directives. They develop cost models, methodologies, and databases necessary to ensure credible CCAs

(and other cost estimates and analyses) throughout the Air Force.

AFCAA may participate on the AoA study team. They conduct sufficiency reviews of ACAT I AoA cost estimates. They also coordinate with the AoA study team to ensure the AoA cost analysis is consistent with the Program Office Estimate (POE). Finally, AFCAA is responsible for establishing and maintaining the Air Force cost library.

HQ USAF/XOC

XOC provides specific oversight of all Air Force AoAs. XOC develops and issues guidance related to the Air Force AoA process. XOC also develops policy and processes for Air Force modeling, simulation, and analysis and forms Process Action Teams (PATs) to resolve AoA issues.

HQ USAF/XOR

XOR serves as the executive agent for managing Air Force-wide mission needs and operational requirements that may result in research, development, test and evaluation (RDT&E) and procurement appropriations. They review all requirements related to the MNS, AoA, ORD/RCM, TEMP, and STAR before a milestone decision. XOR also participates on the AoA study team and appropriate IPT as required.

XOR chairs the AFROC during presentation of the AoA study plan, midterm results, and final results. XOR prepares and issues the MS 0 PMD for starting concept studies. The PMD:

- Designates the lead operating command to develop the AoA
- Identifies and directs all participating organizations
- Identifies funding sources
- Identifies a minimum set of alternatives for consideration

HQ USAF/SC

SC develops command, control, communications, computers, and information (C4I) policy on architecture, integration, and interoperability. They review the MNS, ORD, and AoA to ensure C4I requirements are adequately addressed.

HQ USAF/TE

HQ USAF/TE reviews the final MNS, ORD, and AoA for test and evaluation issues. They also provide overall policy guidance for the development of test and evaluation strategies.

HQ USAF/XOW

XOW reviews the MNS, ORD, and AoA to ensure that sensitivities and aerospace environmental support are adequately addressed.

Air Force Studies and Analysis Agency (AFSAA)

AFSAA reviews and evaluates the MNS, ORD, and AoA documents as required. AFSAA provides selected AoA support and analytical consultation to the participating operational commands and support agencies throughout the AoA process.

Office of the Secretary of Defense Director of Program Analysis and Evaluation (OSD/DPA&E)

OSD/DPA&E provides guidance to the AoA, reviews ACAT ID AoAs, and advises the DAB on the results. Early OSD/DPA&E involvement in AoAs is essential because they review the operating command's approach and recommendation on the most cost effective alternative. They provide current policy and guidance related to costing, campaign analysis, and selection of alterna-

tives. In their costing role, OSD/DPA&E chairs the OSD CAIG. The CAIG reviews selected program costs (usually ACAT ID programs) and reports the results to the DAB.

Defense Intelligence Agency (DIA)

DIA is the DoD authority for threat intelligence and approves threats and threat laydowns used in study scenarios.

Joint Service AoAs

The USA, USAF, USN, USMC, BMDO, and USSOCOM have signed a Memorandum of Agreement (MOA) for Joint COEA Policies, Procedures, and Responsibilities (COEA, for Cost and Operational Effectiveness Analysis, is an older term for an AoA). This MOA identifies how the services will conduct joint AoAs. The central concept is that the lead-service analysis and oversight processes will apply, but will be augmented with participation of the other services. Modification of lead service procedures, appointment of study team members and oversight board membership, division of duties and funding, and program-specific methodologies, analysis issues, and guidance will be articulated in the Joint COEA Tasking Directive (JCTD). The JCTD is developed and staffed similarly to the Air Force's PMD; the differences are that JCTD direction is AoA specific and that organizations outside the Air Force are tasked.

The designated lead service provides the study team director, while a sister service provides a study team co-director. Each service supplies study team members based on needs and available technical expertise. A shortage of technical expertise may require contractor participation. Oversight members are also provided by each service. The study team director and co-director develop the JCTD as early as possible after the milestone decision. Initial efforts identify:

- Service agencies responsible for facilitating the AoA process
- Service agencies responsible for development of the joint AoA
- Service program offices responsible for each of the alternatives
- The OSD/DPA&E contact responsible for the joint AoA

Contract Support for AoAs

Assistance from technical support contractors to conduct substantial parts of the effectiveness and/or cost analysis is frequently necessary. All too often, unfortunately, a contractual arrangement is entered into *before* it is clear what course the AoA will follow. This promotes the likelihood that the chosen contractor is not well suited to the tasks at hand.

The general rule is: know your needs, and then contract. In the final analysis, the responsibility for the AoA rests with the MAJCOM, and it should not be delegated to the contractor.

Principal considerations for deciding on contract support are:

- Is there adequate capability already available within the government?
- Are sources of funding available?
- Which contractors are qualified?
- What are the available contract vehicles?
- How will the contract be administered?

AoAs are not usually budgeted items. Funding sources are the Air Staff, the operating commands, and existing program offices.

AFMC can provide advice on experienced and qualified contractors through the product center XRs and program offices. For most product centers,

access to technical support contractors is available through scientific, engineering, technical, and analytical (SETA) contracts. Also, Federally Funded R&D Centers (FFRDCs) are available to some product centers. Use of an existing contract for the best-qualified contractor can reduce the AoA initiation and development time considerably.

The operating command study team director may brief qualified contractors on the proposed AoA tasks using the initial AoA study plan as a guide. The contractors then provide proposals for the time, costs, and personnel to perform the tasks. If there are no traditional or existing contract vehicles that are suitable, it may be possible to quickly get a contractor on board through existing flexible Government Services Administration (GSA) contracts.

AFMC contracting office personnel should advise on the scope of work, cost of the contract, and the writing of the statement of work (SOW) or statement of objectives (SOO) for the AoA. AFMC is available to act as the Contracting Office Technical Representative (COTR) to administer the contract.

In summary, if contract support is essential, the AoA study team director should work closely with the appropriate IPTs, the Program Element Monitor (PEM), product center (XR), and program offices to resolve the complex issues of funding, contract vehicles, and other contract administration issues.

4 The Study Plan

A major step leading to a successful AoA is the creation of a well-considered study plan. The study plan establishes a roadmap of how the analysis must proceed, who is responsible for doing what, and why they are doing it. Time and effort spent on the study plan before beginning the analysis helps to ensure a high quality AoA, on schedule and within budget. By design, the study plan is structured so much of it can be used later directly in the final AoA report. The study plan must be updated—it's a "living document"—throughout the AoA to reflect new information and changing study perceptions and direction.

Study Plan Preparation and Review

Preparation of the study plan is the responsibility of the using command, and the study director has the ultimate responsibility. The study team writes the plan, often with substantial contractor participation. OAS can also provide experienced help in preparation of study plans.

An intense effort early on by the study director, OAS, and a small group of the core Air Force study team members should be dedicated to drafting an initial study plan. This has proven to be a valuable step in expediting the AoA process, and also defines the focus and schedule for the AoA study. It also provides an opportunity for the Air Force members to understand the complexity and focus of the study in order to define 1) if contractor support is needed, and 2) what the contractor could contribute to the AoA study.

A widespread review of the plan is useful in improving the plan and ensuring support for its execution. Review should start within the originating command.

Outside review can be solicited from a variety of agencies, including OAS, AF/XOC, AF/XOR, AFMC/DR, AFOTEC/XP (when appropriate), and DPA&E (for ACAT ID and IA programs). If AF corporate review is appropriate, OAS, the AFROC, AFC, WIPTs, and the OIPT are available for support.

Appendix A of this handbook lists criteria for judging the adequacy of a study plan in 11 areas. OAS works with each AoA to ensure the study plan is satisfactory. For those study plans that are briefed to the AFROC, OAS provides the AFROC a formal assessment using these 11 criteria.

Study Plan Organization

Here's a suggested outline for the study plan:

1. Introduction
   - 1.1. Background
   - 1.2. Purpose
   - 1.3. Scope
2. Acquisition Issues
   - 2.1. Mission Need
   - 2.2. Scenarios
   - 2.3. Threats
   - 2.4. Environment
   - 2.5. Constraints and Assumptions
3. Alternatives
   - 3.1. Description of Alternatives
   - 3.2. Nonviable Alternatives
   - 3.3. Operations Concepts
4. Determination of Effectiveness Measures
   - 4.1. Mission Tasks
   - 4.2. Measures of Effectiveness
   - 4.3. Measures of Performance
5. Effectiveness Analysis
   - 5.1. Effectiveness Methodology

5.2. Models, Simulations, and Data
5.3. Effectiveness Sensitivity Analysis
6. Cost Analysis
6.1. Life Cycle Cost Methodology
6.2. Models and Data
6.3. Cost Risk Methodology
7. Cost-Effectiveness Comparisons
7.1. Cost-Effectiveness Methodology and Presentations
7.2. Cost-Effectiveness Criteria for Screening Alternatives
8. Organization and Management
8.1. Study Team/Organization
8.2. AoA Review Process
8.3. Schedule
A. Acronyms
B. References
C. Other Appendices as Necessary

For flexibility and ease of access, it is best to include any classified information in separate classified appendices.

Only the first few sections of the study plan are discussed below; others are considered in subsequent chapters of this handbook.

Background

This section describes the developments that initiated the AoA, summarizes relevant analyses that preceded it, and addresses the MNS, ADM, and PMD for the AoA. It also identifies intended results in general terms and notes any applicable ACTDs.

Purpose

This section identifies major acquisition issues to be studied and the milestone supported by the AoA.

Scope

This section identifies the level (engineering, one-on-one, few-on-few, mission, or campaign) and scope of the planned analysis. It identifies any applicable "tailoring" and "streamlining" and the general nature of possible alternative solutions under consideration. The scope should address the extent and depth of the planned analysis in order to provide relevant information for the decision-makers.

Mission Need

This section describes deficiencies in operational capabilities and required system capabilities. It refers to the MNS and ORD (if an ORD exists) and the timeframe of the mission need.

Tailoring and Streamlining

Every AoA is unique and may afford the option to tailor and/or streamline the AoA process for a given situation. The AoA need not be all things to all people, but its audience and their questions must be kept in mind. By focusing the AoA on the appropriate areas, many resources may be saved. The AoA may also be streamlined by either combining or eliminating steps—for example, by compressing review cycles, eliminating unnecessary mid-term reviews, etc.

Memorandums of Agreement and Understanding (MOAs/MOUs)

The AoA process can be helped by MOAs/MOUs between participants. While the PMD locks in the responsibilities of the AoA participants, this may not be adequate in defining responsibilities. MOAs and MOUs can remedy this situation. They can line up analytic support for the effort, assign parties specific responsibilities, provide evidence of a firm commitment from all players, and help the study director when progress is not smooth.

It is important to execute the MOA or MOU at the time the initial study plan is completed—remember, plan "up front and early."

5 Preparing for the Analysis

In this chapter we discuss some of the major inputs to the analysis: the scenarios and threats, the physical environment, constraints and assumptions, the alternatives, and the operations concepts for the alternatives. The decisions made in each of these areas shape the analysis methodology (or plan) and the execution of that plan. Ideally, these inputs would be fixed before the development of the analysis methodology. Almost universally, however, the inputs and plan are developed in parallel, leading to a convergence of the methodology to its final form over time.

Scenarios and Threats

AoA alternatives must be modeled in realistic operational settings to provide reasonable comparisons of their relative performances. The AoA does this by developing one or more appropriate military scenarios. Scenarios define operational locations, the enemy order of battle, and the corresponding enemy strategy and tactics ("the threat"). Scenarios are chosen with consideration of AoA mission need, constraints and assumptions, and the physical environments expected.

The threat is most often developed and defined by the AoA study team working in conjunction the intelligence community. MAJCOM intelligence organizations, DIA, and other intelligence organizations support the AoA and provide detailed threat and target information. Involvement with the intelligence community should be sought early in the AoA. Although the STARs (or STAs) are typically available only after MS I, when they become available they should serve as the basis for the AoA threat description.

The Defense Planning Guidance/Illustrative Planning Scenario (DPG/IPS) provides broad context for a limited number of scenarios and should be used as a starting point for scenario development. The DPG contains a strategic framework and general description of potential military operations in several areas of the world and for various contingencies. Variance from the DPG/IPS must be identified and explained. The details of these excursions must be approved by DIA after OC/IN and 497 Intelligence Group coordination.

The Multi-Spectral Force Deployment (MSFD) or other digital force projections are resources providing details on enemy, friendly, and non-aligned forces in these areas. In joint AoAs, Army, Navy and Marine forces must be considered. The order of battle and roles of allied and non-aligned forces must also be considered. Environmental factors that impact operations (e.g., climate, atmospherics, vegetation and terrain) are important as well.

Typical threat elements addressed in an AoA are:

- The enemy order of battle
- Limitations on threat effectiveness, such as logistics, command and control, operational capabilities, strategy or tactics, and technology
- Countermeasures and changes in enemy strategy and tactics in response to the new system's capabilities (i.e., reactive threats)
- A range of threats to account for uncertainties in the estimates
- A target set representing a cross section of all possible targets
- Threat laydown showing potential threat systems and their location

In summary, scenarios must portray realistic operational environments. A

range of scenarios may be needed to investigate the full potentials of the alternatives and their sensitivities to variations in constraints and assumptions, particularly with regard to threats.

Physical Environment

Threats and scenarios determine the nature of the physical environment in which the alternatives operate. However, there is often a need to operate in a range of physical environments—this can drive the selection of scenarios.

These environments reflect both human and natural conditions. Natural conditions include weather, climate, terrain, vegetation, geology, etc. Depending on the alternative, these conditions can impact the target selection process, the aircraft and munitions selection process, aircraft sortie rate, aircraft survivability, navigation and communications capabilities, logistics, etc. Conditions caused by humans—jamming and chemical/biological warfare are a few examples—have their own impacts. Chemical or biological warfare, for example, may impact the working environment for operational crews and logistics support personnel. This can impact the results of the war or how it is executed. Such real or potential threats may in turn affect aircraft basing decisions and sortie rates.

Constraints & Assumptions

In engineering and the physical sciences, many problems are solved subject to specific boundary conditions, or enforced values of physical parameters at spatial boundaries. The analytical analogs of boundary conditions are constraints and assumptions which affect the nature of the analysis.

Constraints—actual imposed system limitations—can be physical or programmatic. Specifying an operating frequency for a communication system is an example of a physical constraint. Specifying a latest acceptable initial operational capability (IOC) date illustrates a programmatic constraint. Assumptions, in contrast, specify conditions that apply to the analysis. Examples include inclusion of a target type that will proliferate in the future, or forcing consideration of a specific threat system.

Constraints and assumptions arise from many sources. IOC time constraints, for example, may be imposed by an estimated fielding date of a new threat or by the need to replace an aging system. Other constraints and assumptions may be dictated in the ADM or other AoA guidance. Regardless of the source, each constraint and assumption must be explicitly identified by the study team, checked for consistency with other constraints and assumptions, and then accounted for in the analysis methodology. Just as with boundary conditions in a physical problem, analysis results may change significantly with changing constraints and assumptions.

Operations Concepts

Evaluating both the effectiveness and cost of an alternative requires a significant level of understanding of the operations of the alternative. For each alternative, an operations concept must describe the details of the employment of the alternative as it will function within established military organizations.

The complexity of the operations concept will vary with the nature of the alternative and the scope of the tasks. An aircraft will have a more complex operations concept than a munition it carries, and the same munition will have a more complex operations concept than

an attack warning sensor protecting the aircraft.

The following list details many of the potentially appropriate issues an operations concept may discuss:

- Deployment plans, including how the system will be deployed and its deployment schedule
- When and how the system will be employed, including tactics
- Logistics concepts for peacetime and wartime
- Interoperability with other Air Force, sister service, and allied systems
- Incorporation into existing organizational structures, including manpower impacts
- The relationship of the operations concept to existing CONOPS
- Operations concept feasibility
- Linkage of the operations concept to Air Force doctrine

It is difficult to produce operations concepts for developmental and conceptual systems. Typically, system developers are more concerned with the system technology than its employment. The operations concepts for these systems must often be developed from scratch. The operational community with strong must work closely with the technical experts to develop reasonable and realistic operations concepts. It is best to define the requirements for the operations concepts early in the AoA to maximize the available development time.

Selection and Development Of Alternatives

There can be no analysis of alternatives unless there are alternatives to consider. Typically, the ADM and PMD identify a minimum set of alternatives. The study team can augment this set with other appropriate existing systems, modifications to existing systems, systems in development, and conceptual systems. Additional direction during various AoA reviews may insert yet other alternatives.

Practically, the range of alternatives must be manageable. If there are too many alternatives, there will be inadequate resources to perform the analysis. If not enough alternatives are considered, the AoA may not be credible or may not identify the most promising alternative(s). Selecting too few or too many are both possibilities, but experience has shown that selecting too many is the greater danger. The goal is to consider a comprehensive set of alternatives representing all reasonable solutions.

The number of alternatives can be controlled by avoiding similar but slightly different alternatives (avoiding variations on a theme) and by early elimination of alternatives for legitimate cause. Legitimate causes are:

- Non-compliance with AoA guidance
- Non-compliance with treaties or other national policy
- Unacceptable high cost
- Unacceptable performance
- Inability to meet IOC/FOC requirements

Evidence for the last three shortcomings may come from previous studies, expert judgment, or early results from the AoA. Because these criteria are open to interpretation, a disciplined approach for selecting the set of alternatives should be developed and followed to forestall second-guessing. This includes documenting the rationale for excluding non-viable alternatives.

For the same reason, it is important to document the alternatives well; every alternative in the analysis must be supported by these descriptions. To minimize overstatement of alternative capabilities, all descriptions should be made available to all system advocates for peer review.

A base case is always the first alternative, called Alternative 1. The base case represents the existing, currently programmed system funded and operated according to current plans. The base case offers a yardstick against which to measure the potential improvements provided by the other alternatives.

A second frequently included alternative, called Alternative 2, is based on potential yet unfunded improvements to the base case.

All the alternatives after this are numbered in sequence so they may be tracked and compared in an unbiased manner. New or revised alternatives may need to be included after the analysis is under way; these latecomers are generally conceptual solutions based on immature technology and which are still being tuned.

6 Effectiveness Analysis

Effectiveness analysis is the most complex element of the AoA and consumes a significant fraction of AoA resources. The goal of the effectiveness analysis is to determine the military worth of the alternatives in performing mission tasks (MTs). The MTs are derived from the mission needs identified in the MNS. The ability to satisfy the MTs is determined from estimates of alternatives' performance with respect to measures of effectiveness (MOEs) and their supporting measures of performance (MOPs).

The effectiveness methodology is the sum of the processes used to conduct the effectiveness analysis. The development of the effectiveness methodology is almost always iterative: a methodology will be suggested, evaluated against the resources and data available to support it, and then modified to correspond to what is both possible and adequate. As the AoA progresses, this development sequence may be repeated as more is understood about the nature of the alternatives, the models, and what is necessary to support the AoA decision.

Figure 6-1 shows the flow of the analysis tasks discussed in this chapter.

Measuring the Effectiveness of Alternatives

Mission Tasks (MTs)

MTs are derived directly from the deficiencies (mission needs) identified in the MNS. They are usually expressed in terms of general tasks to be performed to correct the deficiencies (e.g., hold targets at risk, provide countermeasures against surface-to-air missiles, or communicate in a jamming environment). The specific nature of the tasks is captured by the MOEs, which are developed to measure success in performing the tasks. Because MTs are tasks, cost is never a MT or an MOE, and cost is never con-

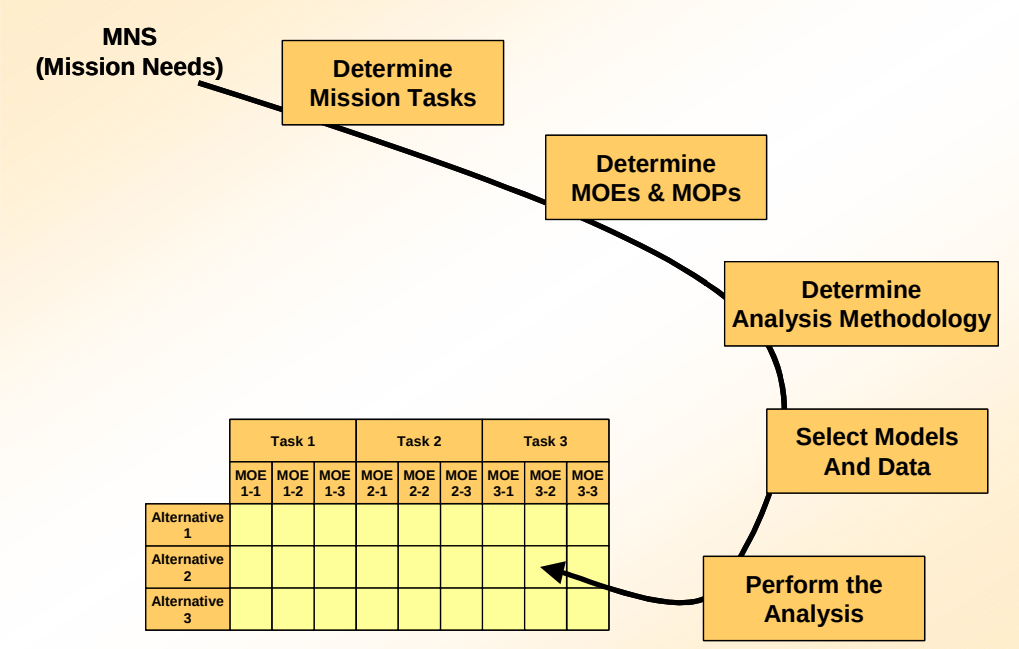

Figure 6-1 : General Approach for the Effectiveness Analysis

sidered in the effectiveness analysis.

All tasks discussed in the MNS should be addressed in the MTs, and only the tasks set forth in the MNS should be addressed by the MTs (barring direction from the ADM or PMD or arising from later oversight of the AoA).

Because the AoA tries to identify the most promising solution(s), MTs must not be stated in solution-specific language. Neither should MTs call for optimizing aspects of a task, because optimizing one aspect of a task usually has unintended impacts on cost or other aspects of task performance. For example, one solution to minimizing aircraft attrition could be not flying missions; this solution would hardly be conducive to placing targets at risk. Similarly, maximizing targets destroyed may result in unacceptable attrition.

Measures of Effectiveness (MOEs)

MOEs contain the details of measuring proficiency in performing a task described by an MT. Though Figure 6-1 shows three MOEs supporting each MT, in some cases there may be only one or two MOEs to support the MT.

Each alternative is evaluated against each MOE, and the results are used to for comparison among the alternatives. While it is generally not advisable to base the analysis on a single MOE/MT, an extensive number of MOEs/MTs may complicate the analysis and make interpretation of the results more difficult.

MOEs are developed by the operating command with assistance from AFMC, AFOTEC, and others. If possible, MOEs should be chosen to provide suitable assessment criteria for use during later developmental and operational testing. This "linking" of the AoA to testing is valuable to the test community and the decision-maker.

MOEs should be reviewed by OSD during development of the AoA plan. Suitable selection of MOEs helps later independent review and evaluation of the AoA study plan and results.

In general:

- MOEs are quantitative (e.g., "how many targets are held at risk?" or "the number of targets by type that you can hold at risk in daytime and nighttime conditions"); MOEs may be qualitative or subjective, calling on the opinion of a knowledgeable person or group, (e.g., "in your opinion does the solution provide a day-night capability?")
- Each MOE supports at least one MT and each MT will have at least one MOE supporting it
- MOEs may support other MOEs as well as MTs; when using hierarchical MOEs, a clear roll-up methodology should be described
- MOEs must be independent of the nature of the alternatives, as all alternatives are evaluated using all MOEs
- MOEs should not be strongly correlated with one another (to avoid overemphasizing particular aspects of the alternatives)
- MOEs are MOEs only in relation to an MT (no quantity is inherently an MOE)
- MOEs are often supported by one or more MOPs

Ideally, MOEs should normally represent raw quantities like numbers of something or frequencies of occurrence. Attempts to disguise these quantities through a mathematical transformation (for example, through normalization), no matter how well meaning, reduce the information content and may be regarded as "tampering with the data." This same reasoning applies to the use of MOEs defined as ratios; a ratio essentially "hides" both quantities.

Results from MOEs not only make it possible to compare alternatives, they also can be used to investigate performance sensitivities to variations of key assumptions and MOP values. Such analyses help define ORD requirements. These results can also be used to investi-

gate the robustness (stability of performance) of alternatives whose defining parameters are subject to significant uncertainty.

Measures of Performance (MOPs)

An MOP is typically a quantitative measure of a system characteristic (e.g., range, velocity, mass, scan rate, weapon load-out, etc.) chosen to enable calculation of one or more MOEs (and possibly other MOPs). MOPs may apply universally to all alternatives or, unlike MOEs, they may be system specific in some instances. MOPs may be directly or indirectly reflected in system performance parameters in the ORD. MOPs and the methodology for evaluating their impact on MOEs frequently help determine ORD requirements. As with MOEs, MOPs should be linked, where possible, to future testing of the alternatives.

Military Worth

The goal of all defense acquisitions is to assist the warfighter. Success at providing assistance can be measured relative to the immediate goals of the system (attack, communicate, detect, etc.) or relative to high-level goals related to "winning the war." For lack of better terms, we will refer to the former as "system worth" and the latter as "military worth." While system worth tells a useful story, military worth has become central to evaluating alternatives in AoAs. Both system and military worth are expressed through MOEs. In this handbook, military worth will refer to a small set of highly significant measures of military performance that are used most frequently at mission and campaign levels. Among these performance measures are:

- Time to accomplish high level objectives
- Targets placed at risk
- Targets negated
- Level of collateral damage
- Friendly survivors
- Numbers and types of resources used

AoAs, especially those employing mission or campaign modeling, should have MOEs relating directly to one or more of these measures. These MOEs will play a leading role in both the effectiveness analysis and the cost-effectiveness comparisons. In the cost-effectiveness comparison, they are typically used to display effectiveness versus cost.

Time to Accomplish High-Level Objectives

The ultimate objective of war is to win. Winning faster means fewer lives lost, less materiel expended, and a lower dollar cost. At a lower level, the time to draw down enemy forces (an air defense system, for example) are potentially significant measures of military worth.

Targets Placed at Risk

Many AoAs examine non-lethal alternatives that improve the lethality of another system. For example, the Global Positioning System (GPS), in providing accurate aircraft positions, has the potential to increase targets placed at risk. A target is at risk when an aircraft arrives undamaged at the weapon release point. Targets at risk are a measure favored by the Electronic Warfare (EW) Partnership.

Targets Negated

Targets negated ("killed") is an obvious measure which introduces complexities not considered in determining targets at risk. Using targets killed requires modeling the interaction of munitions and target, as well as delivery system survivability.

Level of Collateral Damage

For humanitarian and political reasons, there is always concern about the level of collateral damage, both to humans and property, caused by attacking a target. Collateral damage has taken on more importance as military targets have been intentionally integrated into civilian surroundings to deter attack. Estimating collateral damage has become a critical measure for AoAs that examine lethal or lethality-enhancing alternatives.

Friendly Survivors

Some AoAs consider non-lethal, non-lethality-enhancing alternatives. Two examples are the Combat Survivor Evader Locator (CSEL) aircrew survival radio and the Joint Precision Approach and Landing System (JPALS). In such case, military worth may best be measured by the number of "survivors" associated with each alternative in a scenario. For CSEL, an obvious measure is how many downed aircrew members are recovered. For JPALS, the question could be: how many successful landings are achieved?

Number and Types of Resources Used

AoAs are often asked to focus on the resources needed to execute the war or accomplish certain missions during the campaign. These resources are many times measured or stated in terms of number of sorties flown, or numbers and types of targets destroyed. AoAs may require determination of the number aircraft lost (attrition rate), the number of bombs dropped, or the number of weapons to defeat a single target. Often the results are limited to a single target or to a phase of the war.

Effectiveness Analysis Methodology

The effectiveness analysis methodology is designed to compare the effectiveness of the alternatives based on military worth. It encompasses and is influenced by the MTs, MOEs, MOPs, alternatives, threats, scenarios, operations concept, study schedule, and available analysis resources—all the elements of the AoA except cost estimates. The methodology must be systematic and logical. It must be doable, and it must not be biased for or against any alternative. It must also be able to separate the wheat from the chaff (i.e., allow informed decisions). Preparing and executing this methodology is not for the neophyte or the faint of heart.

Discussion of the analysis methodology begins very early in the AoA, perhaps even before the AoA officially begins. Because of its dependence on many factors, it can approach its final form only after these other factors are defined. In other words, you have to know what you are doing before you can decide how to do it—and that includes selecting modeling and simulation software to support the AoA. In fact, final software selection must await development of the MTs, MOEs, and selection of the alternatives.

The basic issues shaping the methodology are:

- Selection of MTs, MOEs, and MOPs
- Selection of the threats and scenarios
- Nature of the alternatives
- Determination of the appropriate level of detail required in the analysis
- Identification of suitable models and data

Types of AoAs and Military Worth

Experience has shown that there is no typical AoA. Every AoA brings with it a new set of issues and problems. We

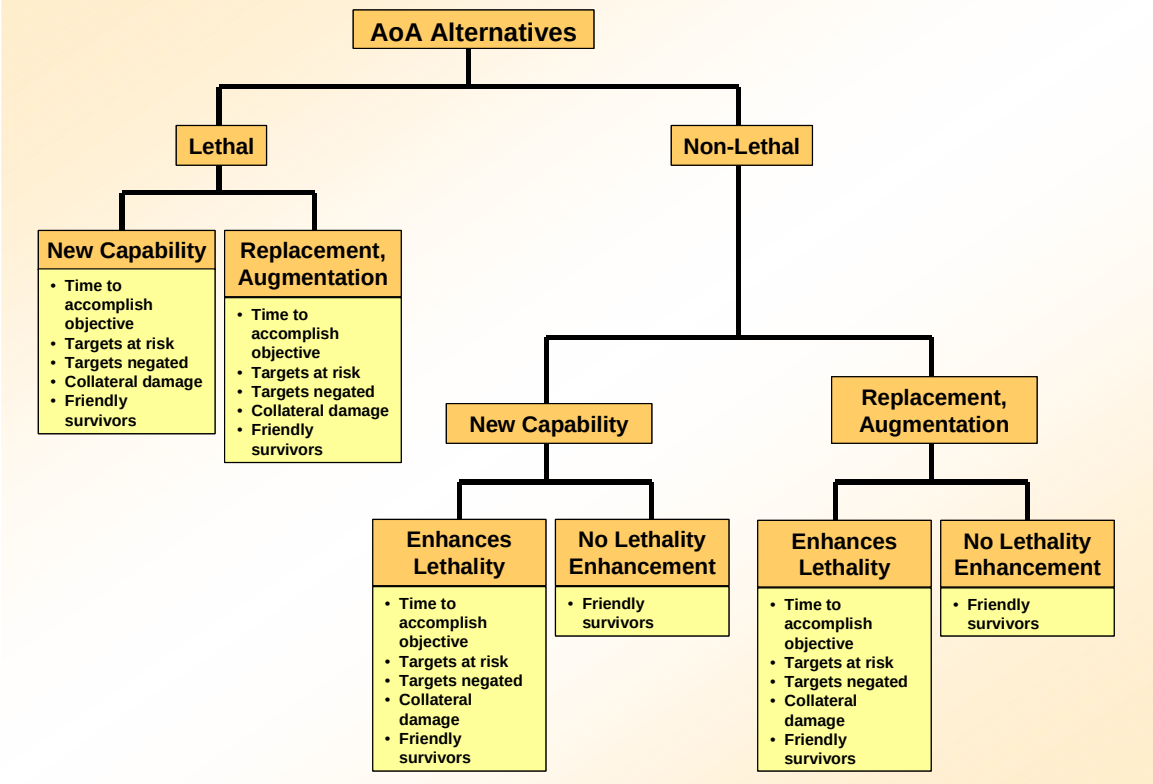

Figure 6-2 : Key Suggested Military Worth MOE Categories

can, however, pigeonhole AoAs into one of six generic types. These types are based on the nature of the mission need and whether or not the AoA seeks a lethal or non-lethal solution. The categories are shown in Table 6-1.

Associated with each type is one or more of the military worth MOEs introduced earlier. Thus, identifying AoA type is tantamount to identifying appropriate military worth MOEs. Appropriate MOEs are shown in Figure 6-2 in a tree structure.

Levels of Analysis

In the world of military modeling, levels of effectiveness analysis are characterized by the number and types of alternatives and threat elements modeled. A typical five-level classification is shown in Figure 6-3.

At the base is the engineering analysis performed on individual components of an alternative or threat system. One level up, one-on-one analysis models the interaction between a single element of the alternative and a single threat system. Examples of one-on-one analyses are weapon versus target or aircraft versus aircraft. At the next higher level, interactions of larger quantities of the same elements are considered, "few-on-few." At the top two levels, mission ("many-on-many") and campaign, the analysis becomes very complex involving the modeling of most or all of the forces in a specific, complex scenario.

At each higher level, the focus of the analysis changes, the applicable models change, and the complexity of the analysis changes. Analysis at one level will generally require supporting analysis at the lower levels. While the supporting analysis may come from sources outside the AoA, it will be often be performed by the AoA team. MOP values tend to

Table 6-1 : Categorizing AoAs

	Satisfying mission needs requires new capability	Satisfying mission needs requires replacement, upgrade or augmentation of an existing capability
Mission need is for a lethal system	We need a lethal capability against a new target type for which there is no existing lethal capability	We need an upgrade or replacement of an existing attack aircraft that is near the end of its useful life
Mission need is for non-lethal system that enhances lethality of other systems	We need a new ISR capability to locate a new class of targets	We need to eliminate an existing communications shortfall
Mission need is for non-lethal system that doesn't enhance lethality of other systems	We need an effective countermeasure for a new SAM threat	We need to improve the ability of aircraft to land under adverse conditions

be produced from engineering and one-on-one analyses. MOE values tend to come from higher levels of analyses. There are no hard and fast rules, though, because of the range of issues considered in AoAs.

Given the increasing complexity of the analysis encountered in moving up the pyramid, every effort must be made to use the lowest level needed to answer the AoA's questions. This said, most ACAT I AoAs will require a minimum of mission level modeling.

Hard vs. Soft Analysis

Analytical techniques can be classified as "hard" or "soft." Hard analytical techniques are based on the ability to describe issues in terms of mathematical relationships that allow the use of quantitative modeling and simulation. Soft techniques rely on judgments based on experience. These judgments are usually made by a group of knowledgeable individuals designated as "experts."

Table 6-2 lists some of the advantages and disadvantages of both hard and soft analysis. The advantages of one technique are often the disadvantages of the other. In general, hard techniques, when practical, are significantly preferable to soft techniques. Exclusive use of soft techniques such as Delphi, Analytical Hierarchy Process (AHP), and Value Focused Thinking in an AOA are justifiable only when the suitable input data, time, or funds to carry out a quantitative analysis are lacking.

Figure 6-4 illustrates the perception (reality) that uncertainty in the analysis results is inversely related to the level of effort. The bottom line: while experience can be invaluable, it is nearly

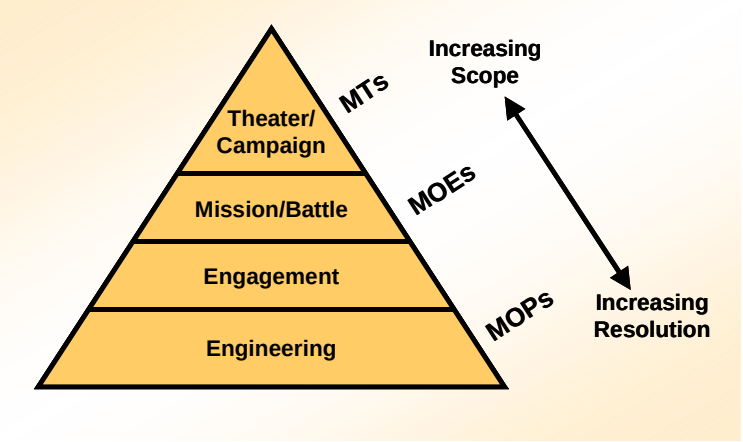

Figure 6-3 : Classification of Models

Table 6-2 : Advantages and Disadvantages of Hard and Soft Analysis Techniques

	Advantages	Disadvantages
Hard Techniques	• Repeatable • Support parametric analysis • Reduce bias; magnify existing biases	• Require significant input data • Require significant time and skill to produce and interpret answers • Require understanding of mathematical relationships
Soft Techniques	• Provide quick answers • Require little quantitative input data • Don't require understanding of mathematical relationships • Apply to complex subjective issues • Require about the same effort regardless of issue complexity	• Influenced by experts involved (no guarantee of repeatable results) • Not well-suited to parametric analysis • Experts may have narrow or widely divergent interests, expertise my vary widely • May not use best qualified experts (they may not be identified, unavailable, or too expensive) • Results difficult to interpret relative to quantitative goals

impossible for humans to consider accurately the simultaneous interactions of multiple complex factors. That experience is better used to shape the mathematical model of the interactions.

As a practical example, do you want the crash safety features of your car determined by experts based solely on their experience? Or would you rather have their experience used to interpret modeling and testing of competing options? Now, imagine yourself as a decision-maker and ask yourself a similar question about the AoA results you are judging.

Selection of Models and Data

Models and simulations (collectively referred to as models for this discussion) are idealized representations of reality. They are the heart and soul of analysis and can consist of everything from hand-written steps executed with a "stubby pencil" to elegant mathematical formulations represented by thousands of lines of computer code. In some cases, they may include person-in-the-loop simulations. Whatever their complexity or form, however, there comes a point when the AoA team must decide which ones to use to generate comparisons of the alternatives.

The first rule of model selection is: Select models that deliver what is needed. Breaking this rule for convenience (for example, because of easy accessibility to a particular model) may result in the wrong issues being investigated and the wrong alternatives being identified. What is needed is defined primarily by the MOEs. Once the MOEs are known, the necessary level(s) of analysis, engineering through campaign, can be identified and a search can be conducted for models suitable for MOE calculations.

The search for models considers:

- Model inputs and outputs
- Who is available to run the model
- What vehicles are available to fund running the model
- Whether or not the model can support the projected volume of runs within time and funding constraints
- What level of acceptance the model has in the analysis community

Model inputs come from all aspects of the AoA: threats and scenarios, alternative definitions, operations concepts, constraints and assumptions, etc. Inputs are also derived from the outputs of other models. Before selecting a model, the sources of all inputs should be identifiable. Model outputs help determine a model's suitability to calculate MOEs and their supporting MOPs. Figure 6-5 suggests one method of presenting inputs, their sources, and the corresponding outputs.

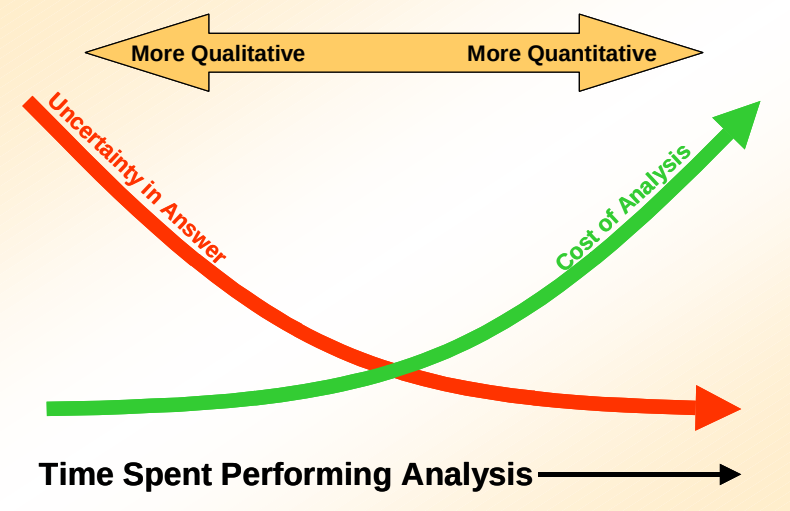

Figure 6-4 : Notional Relationships Between Analysis Time and the Cost and Uncertainty of Results

Before settling on a final integrated set of models, one must have "proof" that the set is sufficient for the AoA; this "proof" can be obtained by constructing a linkage diagram similar to the schematic in Figure 6-6. Such a figure shows the source of every MOP and MOE value.

Every model must be run by experienced, competent analysts. Experienced analysts are the best guarantee of obtaining reliable, consistent results. Unfortunately, experienced analysts are in limited supply; this shortage is even more severe for the complex models. Availability of analysts will impact model support options, specifically the choice of a support agency or contractor. This choice may be further limited by sources of funding and available contracting vehicles. It is unusual for an AoA to be both funded and have a schedule able to accommodate competitive bidding for technical support.

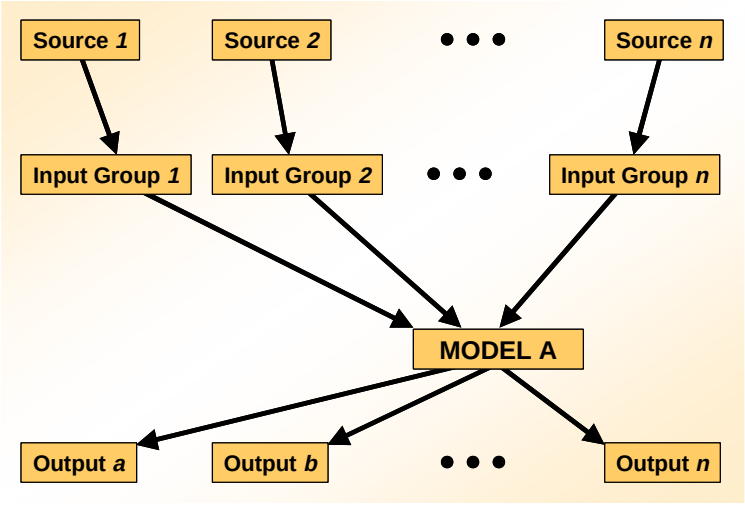

Figure 6-5 : Schematic Example of Identifying Model Inputs, Sources, and Outputs

Every model requires time and effort to set up and run: a particular model should be selected only if the resources are available to perform all necessary runs in a timely manner. Unfortunately, early in the AoA an accurate judgment of tasks versus resources is difficult to make; there are no clouds on the horizon and optimism reigns. Reality intrudes only later when input data are late, when previously unidentified bugs are found in the soft-

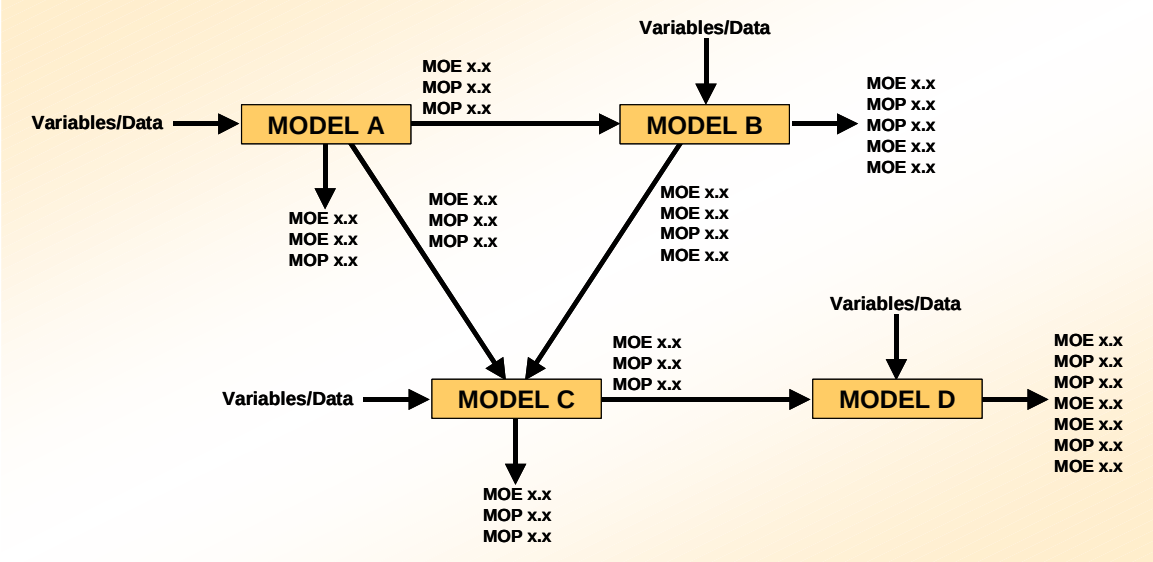

Figure 6-6 : Schematic Showing Model Linkage and MOE/MOP Relationships to Models

ware, or when the model expert retires. As undesirable as it is, it is not unusual for the scope of the analysis to be reduced due to such problems.

The last area of consideration is model acceptance. Does the analysis community deem the model suitable for the intended usage? If not, is it reasonable to believe that the model can be accredited for that usage? If the model is a legacy model used in an accepted way, the answer will be easy. If not, the analysis community may need to be convinced of the appropriateness of the proposed usage. Regardless, model validation, verification, and accreditation (VV&A) must be performed for each model.

When suitable existing models cannot be found, either old models must be modified or new models must be developed. Because of the need to find funds for this work and the likelihood of delays, these are options of last resort.

AFMC product centers, as well as other analysis agencies and modeling centers, can provide modeling and data support. OAS can provide advice related to appropriate models and data to the operating commands.

Due to its enduring value in the analysis and in the system's continuing development, testing and operation, the use of contractor proprietary models and databases is strongly discouraged.

Legacy Model Toolkit and Pedigreed Data Bases

USAF/XOC has defined a standard Air Force modeling and simulation toolkit that contains 18 legacy models. The purpose of the toolkit is to meet the needs of the analysis community while minimizing the costs of model proliferation. The toolkit models all have a long history of use (lending them credibility) and they are assumed to be verified and validated for uses consistent with their history. The toolkit model managers are asked to provide a standard version of the model and a corresponding "pedigreed" database. They are also expected to work with system program offices (SPOs) to ensure that current and new weapons systems are represented accurately in their models. Any study that uses a model not in the toolkit will need to justify that use.

Engineering level models are beyond the scope of the toolkit. The Air Force

recognizes that these are so specific in application and so numerous as to preclude tracking and controlling them in a centralized manner.

XOC has a plan to transition from the toolkit to the next generation models: JMASS, JWARS, JSIMS, and the Next Generation Mission Model (NGMM). Before transitioning, each next generation model will have to demonstrate the functionality of all of the models it is replacing.

Verification, Validation and Accreditation (VV&A)

As AoAs expand the use of M&S to reduce risk and resources expended in the acquisition process, there is an increasing need to ensure the credibility of models and simulations, including input data. As a result, DoD and Air Force regulations now require that software and data be accredited for each major acquisition. This section presents a practical and affordable approach to VV&A.

Model verification is the process of determining that the model accurately represents the model developer's conceptual description and specification. Model validation is the process of determining the extent to which the model is an accurate representation of the real world with respect to its intended uses. Accreditation is an official determination that a model is acceptable for a specific purpose.

Model accreditation begins with development of the accreditation plan. The plan contains criteria for model assessment based on the ability of the model to accept the required input data and to provide appropriate output information to resolve the MOEs. All data used for model input and scenario configuration should also be validated to ensure credibility of the output. If a model has undergone prior V&V that will satisfy the plan developed for the AoA, the results of the prior effort can be used in the accreditation of the model.

A review of the V&V results will support the accreditation recommendation. Typically, the accreditation process uses a categorical grading scheme to describe suitability. An example of a categorical suitability range would be:

- Use
- Use with limitations
- Conduct additional V&V
- Additional model development needed
- Do not use

The accreditation report contains the V&V plan, a description of the accreditation process, and the accreditation recommendation. The report is sent to the accreditation authority (usually the DR of the AoA lead MAJCOM) for approval. The accreditation report is included as an appendix to the AoA final report.

As with models, data should be subjected to a formal VV&A process. Developing a validated database for the AoA does this. Performance data must be technically and operationally validated by engineering assessments or performance tests. Additionally, current tactical and employment doctrine must be reflected in the database. Collection, validation, and maintenance of the AoA database are the responsibility of the operating command. Any organization creating, maintaining, using, and disseminating cost or effectiveness data must ensure the reliability of the data for their intended use. The cost data selected to support the AoA should be accredited by the responsible costing agency. The Defense Intelligence Agency (DIA) should validate the threat

data. Data is a long lead item—start the collection process early.

The accreditation report will identify model strengths and weaknesses, as well as describe the MOEs analyzed by the model. Each model will be analyzed independently using assessment criteria and rating scales similar to those in Table 6-3. Although still primarily qualitative in nature, such criteria help to quantify the confidence assessment. The first four criteria are assessment drivers. That is, a 'red' in any of these four areas should warn the accreditation authority that the credibility of the model for this use is questionable. The accreditation report should, at a minimum, address the following:

- Specify M&S reference version number, plus all hardware and software identification or version numbers used in supplying inputs
- Identify model input data suppliers
- Identify key V&V planning, technical review, and implementation participants or organizations and their V&V responsibilities
- Describe V&V methodologies, implementations, and their results
- Describe verification, validation, and certification (VV&C) activities performed on input data sets used in V&V activities
- Identify V&V criteria (MOEs/MOPs)
- Describe additional model strengths, weaknesses, or limitations identified as a result of the V&V activity, with recommended remedial actions

OAS personnel are available to help AoA teams develop the accreditation recommendation report.

Conducting the Analysis

Analysis Team Leadership

Choosing the leader of the analysis team may be the most critical choice made by the study team leader. Ideally, the candidate will be an experienced analyst possessing creativity, management and organizational skills, and able to work well with people having disparate backgrounds, interests, and prejudices. Unfortunately, few meet all these criteria. Thus, the study team leader must be flexible, considering contractor leadership or shared government and contractor leadership for the analysis. For similar reasons, contractor personnel may also make up a significant proportion of the analysis team.

Technology Advocates

Frequently, technologies are incorporated into system designs of alternatives before the analysis methodology (especially definition of MTs and MOEs) is complete. As a result, it may be necessary to revise the original alternative designs as the methodology matures. To ensure the refinements to the alternatives reflect the best performance the technology can provide, every alternative needs an enthusiastic advocate to make the necessary adjustments.

Flexibility in Analysis

The need to scale back the planned analysis in an AoA is common; reasons range from delays in obtaining data to mismatches between available resources and desired outputs. This makes it important to design an analysis that is flexible in scope. Without flexibility, often the only choice is to slip the AoA schedule. While at times this can be tolerated, often it cannot.

Dealing with Contentious Issues

As a practical matter, decisions on controversial issues must have buy-in from everyone. This may frequently be obtained through compromise or by adding "excursions" to the planned set of options to be examined. Avoid trying to formulate these solutions in a large

group. If possible, have potential solutions in hand, ready for consideration. If a solution cannot be agreed upon quickly, allow the pros and cons of different points of view to be raised, then cut off discussion and return to the issue later. Groups are far better at solving problems at lunch or during breaks than in the formal setting of a meeting.

Presenting the Effectiveness Results

Effectiveness results need to be clearly and succinctly packaged, and their presentation must minimize opportunities to mislead. The basic effectiveness results are the MOE evaluations for each alternative. These results do not consider cost and are therefore intermediate results. However, the effectiveness results should still be presented because they have not been sullied by interpretation and because they are usually the most easily understood—hence most easily questioned—results you have to present.

Rolling Up the Results

Once the MOE evaluations have been presented, it may also make sense to "roll up" these results. Rolling up results describes any process, which aggregates results for individual alternatives. A roll up allows comparing the alternatives using a smaller number of measures. The advantage of having a smaller number of measures carries the obvious disadvantage: information, and along with it potential insight, is lost in the roll up process. Aggregation is acceptable only when the rationale for doing it is sound. This means:

- The aggregation arises naturally from relationships among the MOEs
- The significance of the aggregates is clear
- The aggregates tell a clearer story than the individual MOEs

These are difficult criteria to meet, but nothing less makes good sense. The message is: don't aggregate just to aggregate.

Weighting MOEs

In the roll up process, a frequent issue is whether or not to weight the MOEs. Weighting assigns different values (weights) to different MOEs. It is a seductive idea: clearly not all MOEs are created equal. A difficulty with weighting, however, is that an analyst's weights may not be a decision-maker's weights. By weighting, the analyst is proclaiming judgment superior to that of the decision-maker.

Weighting is strongly discouraged. Almost invariably, weighting is an attempt, conscious or otherwise, to avoid thinking through alternative methods of presenting the results in a clearer manner. Better presentations almost always can be found; take the time to look for them.

Table 6-3 : Accreditation Rating Criteria

	Criteria	Rating Scale
Risk	Assess the analysis for 1) timely and accurate representation of the natural environment, 2) authoritative representation of human behavior, and 3) authoritative representation of the subject(s)	**RED:** Model not appropriate for intended purpose; do not use for this study **YELLOW:** Relevant model of environment, behavior, or system **GREEN:** Demonstrated adequacy for intended purpose
Input Data	Assess the input data used to describe the three representations above	**RED:** Data are arbitrary or best guess; data not reviewed **YELLOW:** Most data are traceable to certified sources; data reviewed **GREEN:** All data are valid or certified or pedigreed
Critical Elements Modeled	Compare the M&S capability to the application criteria...can the model address the inherent issues associated with the MOEs?	**RED:** MOE functionality not modeled **YELLOW:** Functionality indirectly contributes to the MOE, or offline analysis required **GREEN:** MOE functionality directly modeled
User Experience	Assess the experience, credibility, and capabilities of the AoA analysis team	**RED:** User has no modeling experience, nor prior expertise with this model **YELLOW:** User has limited expertise with this model **GREEN:** User has expertise with this model, or is the developer
History	Review the M&S development history, summarize past application(s), and define the application domain based on a description of the capabilities by the M&S developer (AFI16-1001)	**RED:** No history; new model **YELLOW:** Some history, primarily undocumented; well documented lineage **GREEN:** Lineage completely documented
Configuration Management	Review the adequacy of the model's configuration version control; complete an acceptable face validation examination, if appropriate (AFI16-1001)	**RED:** No formal configuration management process **YELLOW:** Some configuration management process for all major upgrade/code changes **GREEN:** CCB process for all changes
Documentation	Ensure model documentation exists and is current/sufficient for the intended use (normally includes M&S conceptual model, user's guide, and programmer's and analyst's manuals) (AFI16-1001)	**RED:** No published documentation **YELLOW:** Published documentation for previous version; change documentation developed but not published **GREEN:** Complete set of documentation exists for version used
User Community	Compare the analysis with known US and international analysis standards and techniques	**RED:** Limited user community for specialized applications not related to current use **YELLOW:** Small user community; no formal users group **GREEN:** Formal users group representing wide range of application
Prior V&V	Ensure data sources have been identified and that both producer and user data VV&C were accomplished (AFI16-1001)	**RED:** No prior V&V **YELLOW:** Some V&V on previous version; face validation for current use **GREEN:** Well documented V&V including live test results and/or model comparisons; prior accreditation reports

7 Cost Analysis

A cost analysis is performed in parallel with the operational effectiveness analysis. It is equal in importance in the overall AoA decision process. It estimates the total life cycle cost (LCC) of each alternative and its results are combined with the results of the effectiveness analysis to identify the alternative(s) that represent the best Air Force or joint value.

The LCC approach captures the total cost of each alternative over its entire life cycle and includes costs incurred for research and development (R&D), investment, operations and support (O&S) and disposal at end of system life. It does not include sunk costs (money already spent) that do not affect the decision. Sunk costs may be of interest to decision-makers, however, and should be identified separately.

The AoA LCC analysis is based on peacetime operations and does not include any war-related costs such as replacement of expended or attrited assets. The impact of consumed assets is reflected as diminished effectiveness in the operational effectiveness analysis.

LCC Elements

Research and Development Cost

The costs of all R&D phases—concept exploration, program definition and risk reduction (PDRR), and engineering and manufacturing development (EMD)—are included in this cost element. There are many types of R&D costs: prototypes, engineering development, equipment, test hardware, contractor system test and evaluation, and government support to the test program. Engineering costs for environmental safety, supportability, reliability, and maintainability efforts are also included, as are support equipment, training, and data supporting R&D efforts.

Investment Cost

The cost of investment (low rate initial production—LRIP—and production phases) includes the cost of procuring the prime mission equipment and its support. This includes training, data, initial spares, war reserve spares, preplanned product improvement (P3I) program items, and military construction (MILCON). MILCON cost is the cost of acquisition, construction, or modification of facilities necessary to accommodate an alternative. The cost of all related procurement, such as modifications to existing equipment, is also included.

Operating and Support Cost

O&S costs are those program costs necessary to operate, maintain, and support system capability. This cost element includes all direct and indirect elements of a defense program and encompasses costs for personnel, consumable and repairable materiel, all appropriate levels of maintenance, facilities, and sustaining investment. Manpower estimates should be consistent with the Manpower Estimate Report (MER), which is produced by the operating command manpower office.

For more information, refer to the OSD Cost Analysis Improvement Group's *Operations and Support Cost Estimating Guide*, May 1992.

Disposal Cost

Disposal cost is the cost of getting rid of excess or surplus property or materiel from the inventory. It may include costs of demilitarization, detoxification,

redistribution, transfer, donation, sales, salvage, or destruction. It may also reflect the costs of hazardous waste disposition (including long-term storage) and environmental cleanup.

Cost Analysis Responsibility

The operating command financial management office is responsible for conducting the AoA cost analysis, and they will normally chair the Cost Working Group (CWG). The CWG should include representatives from specific operating and implementing command organizations with expertise in cost analysis and knowledge of the system alternatives. A logistics analyst on the CWG can assess the cost implications of logistics support approaches.

OAS will sit on the CWG to assist and advise the operating command financial management team. AFCAA will attend the kick-off meeting to provide overall costing guidance, and maycon-duct a sufficiency review of each ACAT I AoA estimate.

Typically, the CWG will be responsible for the following cost analysis tasks:

- Developing appropriate costing ground rules and assumptions and ensuring they are consistent with effectiveness ground rules and assumptions
- Defining the Work Breakdown Structure (WBS) to be used in the cost analysis; the WBS is a hierarchical organization of the items to be costed
- Defining the logistics elements necessary for the cost analysis
- Providing LCC estimates for the baseline system and each alternative
- Sufficiently documenting the cost analysis so that a qualified cost analyst can reconstruct the estimate using only the documentation and references provided in the final AoA report
- Reviewing estimates to ensure the methodology and the ground rules and assumptions are consistent and the LCC estimate is complete (i.e., all relevant costs are included and all programmatic, technical, and schedule issues are addressed)
- Bounding all LCC point estimates with uncertainty ranges
- Including programmatic data in the LCC analyses, such as quantities and delivery schedules (when known)
- Identifying cost drivers (those elements to which LCC is most sensitive) and performing sensitivity analyses on significant cost drivers
- Providing funding and affordability constraints and specifying any limitations imposed by schedule
- Providing necessary cost data to implement Cost as an Independent Variable (CAIV) strategy to arrive at an affordable balance among cost, performance, and schedule
- Presenting all costs in base year dollars (BY$)—normally the year in which the decision will be made—and also in then year dollars (TY$) if a production schedule is known; identifying the appropriate inflation indices used (normally the most current OSD indices published on the SAF/FMC web page)
- Where possible, separately identifying sunk costs for each alternative
- Addressing manpower implications for each alternative in the O&S costing, including contract support where applicable
- Addressing appropriate environmental regulations, treaties, etc., in determining disposal costs
- Addressing sources that are driving cost risk and uncertainty for each alternative
- Consulting with OAS on the latest guidance related to the AoA report format for cost

Table 7-1 shows a notional “cost responsibility matrix” which may be useful to assign and track CWG taskings. Specific responsibilities will vary with each AoA.

LCC Methodology

LCC analysis allows alternatives to be compared to the baseline system based on their relative estimated costs. The LCC methodology is initially outlined in the study plan and updated as the AoA proceeds. While the LCC analysis of all alternatives must be based

on the same WBS, the level of alternative description available to the cost analyst—and thus the fidelity of the estimate—will vary depending on the detail of system definition and its technological maturity.

Ground Rules and Assumptions

As part of the cost methodology, the AoA study plan should identify general ground rules and assumptions underlying the analysis as well as those specific to

Table 7-1 : Cost Responsibility Matrix

	OC/FM	OAS	AFCAA	SPO 1, Product Center	SPO 2, Product Center	Logistics Center	Due Date
Develop ground rules and assumptions	X	X					
Develop WBS	X		X	X	X	X	
Develop/review cost methodology	X	X	X	X	X	X	
Identify cost models and data sources	X	X	X	X	X	X	
Write cost section of study plan	X	X					
Provide data requirements to other working groups	X			X	X	X	
Develop, amend, and document LCC				X	X	X	
Identify cost drivers				X	X	X	
Identify phase-in and steady state periods and quantities				X	X	X	
Assess AoA milestone schedules	X	X	X	X	X	X	
Perform cost and schedule risk analysis				X	X	X	
Perform sensitivity analysis				X	X	X	
Time phase estimates, convert to TY$				X	X	X	
Analyze cost results	X	X		X	X	X	
Write cost section of AoA report	X	X					
Prepare cost briefings for reviews	X	X					
Provide guidance, conduct sufficiency reviews		X	X				

particular cost elements or life cycle phases (e.g., an assumption that no additional manpower is required to employ any alternative). At a minimum, a preliminary list of ground rules and assumptions should address the following:

- Cost basis of the estimate (specified BY$)
- Specific inflation indices used
- Definition of sunk costs (date separating costs expended or contractually committed from those to be included in the LCC estimate)
- Schedule issues, including major milestones and significant events (IOC and FOC dates, production schedules and quantities, etc.)
- Basing, logistics, and maintenance concepts
- MILCON & intelligence support requirements
- Environmental cost considerations
- Personnel requirements and constraints
- Affordability constraints

Work Breakdown Structure

The LCC methodology is generally based on a WBS. A WBS is a product-oriented (as opposed to functionally-oriented) tree composed of hardware, software, services, data and facilities that define the product to be developed and

Table 7-2 : Notional Work Breakdown Structure for Aircraft System

Aircraft System	**Air Vehicle**	Airframe
		Propulsion
		Air Vehicle Software
		Armament
		Weapons Delivery
		etc.
	Systems Engineering & Program Management	*(no Level 3 breakdown)*
	System Test and Evaluation (T&E)	Development T&E
		Operational T&E
		T&E Support
		Test Facilities
	Training	Equipment
		Services
		Facilities
	Data	Technical Publications
		Engineering Data
		Management Data
		Support Data
	Peculiar Support Equipment	Test & Measurement Equipment
		Support & Handling Equipment
	Common Support Equipment	Test & Measurement Equipment
		Support & Handling Equipment
	Operational/Site Activation	System Assembly, Installation & Checkout
		Contractor Technical Support
		Site Construction
	Industrial Facilities	Construction, Conversion, or Expansion
		Equipment Acquisition or Modernization
		Maintenance (industrial facilities)
	Initial Spares & Repair Parts	*(no Level 3 breakdown)*

produced. Table 7-2 shows a notional WBS for an aircraft system and illustrates the typical elements found at the first three WBS levels (succeeding levels contain greater detail).

Once the WBS has been created, costs are collected for each WBS element and the LCC estimates developed for each alternative. AoA alternatives are not normally estimated below WBS Level 3.

For a complete WBS, consult MIL-HDBK 881B, 2 January 1998.

Cost Estimating Methodologies

There are several cost estimating methodologies available to the analyst. The three formal approaches include the engineering build-up (or bottom-up technique), the parametric estimating technique, and the analogy technique. Informal approaches like expert opinion can also be used when the formal techniques are not practical.

The engineering build-up approach is performed at a detailed level of the WBS. Cost can be estimated for basic tasks like engineering design, tooling, fabrication of parts, manufacturing engineering, and quality control. The cost of materials may also be estimated. The disadvantages of this approach are its time-consuming nature—the modeled processes must be well understood—and the need for detailed, actual cost data.

The parametric method is normally appropriate at the early stages of a program when there is limited program and technical definition. It involves collecting relevant historical data at an aggregated level of detail and relating it to the area to be estimated through generally simple mathematical equations—known as cost estimating relationships (CERs). CERs relate cost to one or more variables (e.g., volume, weight, or power). Usually less detail is required for this approach than for other methods. Since CERs are based on actual program cost history, they reflect the impacts of system growth, schedule changes, and engineering changes. When costs are captured at a very high level, however, visibility into more detailed levels is lost.

The use of a factor or ratio relating the cost of one entity to another is also considered a form of parametric estimating (for example, training costs might be estimated as 20% of production costs). Factors and ratios allow the estimator to capture a large part of an estimate with limited descriptions of both the historical database used to develop the factor and the program to be estimated. This method is often used for training, data, peculiar support equipment, and systems

Table 7-3 : Cost Models and Data Summary

		Cost Element				Risk Analysis
		R&D	Investment	O&S	Disposal	
Models	ACEIT	X	X	X	X	X
	PRICE	X	X			
	SEER	X	X			
	CORE			X		
Data	Analogous Programs	X	X	X	X	X
	Current Contracts	X	X	X		X
	Engineering Estimates	X	X	X		X
	Vendor Estimates	X	X	X		X

engineering and program management.

The analogy method uses actual costs from a similar program and adjusts for the new program's complexity and technical or physical differences to derive the estimate. This method is normally used early in a program cycle when there is insufficient actual cost data to use as a basis for a detailed approach. Engineering assessments are necessary to ensure the best analogy has been selected and proper adjustments are made. These engineering judgments are the mainstay of the approach and can also be a limiting factor.

Table 7-4 : Generic LCC Summary (All Alternatives)

	R&D	Investment	O&S	Disposal	Total LCC
Alt #1					
Alt #2					
Alt #3					
...					
Alt #*n*					

Cost Risk and Uncertainty

Because a cost estimate is a prediction of the future, there is a significant concern that actual costs may differ from the costs developed in the estimate; risk and uncertainty analyses address this concern. Most cost estimates are a composite of both risk (known-unknowns) and uncertainty (unknown-unknowns). However, "risk" is often used generically to address both types of "unknowns."

Risk stems from three primary sources: configuration changes, technical and schedule problems, and cost estimating error. Technical and schedule risk and cost estimating error can be accounted for in the risk analysis, but major configuration changes may require a new estimate rather than trying to compensate by applying a risk approach.

Several approaches are available to treat risk in an estimate; they range from very subjective to those with complex statistics. Whatever risk methodology the cost analyst decides to employ, it should be adequately described in the study plan. The results of the risk analysis will be included in the final cost estimates, often as a cost range rather than as a discrete point estimate.

Cost Models and Data

Cost models incorporating these three methodologies are available to help the cost analyst derive the LCC estimates. The LCC databases used in these models should be accredited by the responsible agencies. The models and data intended for use in the AoA should be identified and described in the study plan. The matrix in Table 7-3 summarizes this information.

For a list of models thoroughly tested in the weapons development and O&S communities, contact the Air Force Cost Analysis Agency (AFCAA).

Cost Presentations

The format illustrated in Table 7-4 is typically used to display the AoA cost analysis results; it allows the costs to be directly compared. This format should be used to present both BY$ and TY$. Table 7-5 also presents each alternative's cost in terms of fiscal year spread and appropriation. Again, this format can be used for both BY$ and TY$. The results should also be analyzed graphically in a presentation. Sunk costs are excluded from the estimates in these tables.

Table 7-5 : Generic LCC Summary (by Alternative)

Alternative *n*	FY01	FY02	FY03	FY04	FY05	...	FY*nn*	Total LCC
3010 Aircraft Procurement								
3020 Missile Procurement								
3080 Other Procurement								
3300 Military Construction								
3400 Operations & Maintenance								
3500 Military Personnel								
3600 RDT&E								
Total LCC								

Cost Documentation

A complete set of cost documentation is an essential part of the AoA cost analysis. Without an explanation of the data sources and methodology used for each element of the estimates, the costs cannot be replicated and lack credibility. Chapter 3 of Air Force Instruction (AFI) 65-508 provides guidance on the level of documentation required. Attachment 5 to the same instruction contains a cost documentation checklist useful in determining the completeness of the cost documentation.

Cost Reviews

The CWG and AoA study team review the cost estimates for consistency and completeness. OAS also reviews the cost section of the study plan and the final results as part of the overall AoA assessment they provide to the AFROC. For ACAT I AoAs, the AFCAA will perform a cost sufficiency review for all viable alternatives. These sufficiency reviews assess the completeness, reasonableness, and consistency of the estimates and provide a confidence rating for the estimate; they also highlight any problem areas. For these reasons, it is strongly recommended that the study director request a sufficiency review of the AoA estimates.

8 Cost-Effectiveness Comparisons

Cost-effectiveness comparisons simultaneously consider alternatives' cost and effectiveness. As consumers, we are all familiar with the concept of cost-effectiveness. Whether buying laundry detergent, a new car or a home, we collect data on cost and make assessments on how well the alternatives will meet our needs (how "effective" they are). With data in hand, we make our comparisons and select a winner. In an AoA the process is essentially the same, although usually more formal.

While this kind of cost-effectiveness "analysis" is quite sensible, from experience we are also aware that it has difficulty in addressing some items: the need to determine if additional effectiveness is worth additional cost and the need to assess the relative values ("weights") of different measures of effectiveness. The first of these problems is illustrated in Figure 8-1; the second in Figure 8-2.

From Figure 8-1 we could safely conclude that we would not select Alternative 2, but the issue is not clear for Alternative 3 and Alternative 4. Alternative 3 and Alternative 4 will be chosen if the increase in effectiveness is judged to be worth the cost. The decision may be somewhat easier if there is a minimum acceptable effectiveness threshold (for example, from the ORD); this would allow the use of a number of the MOEs that are considered critical to accomplishing the mission tasks. With these MOEs, you may be able to consider the alternatives that meet or exceed all of the critical MOEs as the final step leading to selecting the preferred alternative. However, the threshold may be exceeded by more than one alternative as illustrated, and having a threshold does not eliminate the option of "buying nothing" if all alternatives meeting the threshold are deemed too costly.

Figure 8-2 shows the second type of dilemma. In this illustration, if MOEs a–c have equal weight, there is little to differentiate among the choices. If, on the other hand, they are not weighted equally, then the three alternatives may differ substantially in overall effectiveness. The question is, "Who makes the judgment?"

The decision-maker should be making the judgment concerning the important aspects of the analysis, not the analysts.

In this case we may solve the problem by asking the decision-makers to provide the weighting for the MOEs, identifying the important ones with higher weights. Often, however decision-makers are reluctant to provide these weighted values until the final

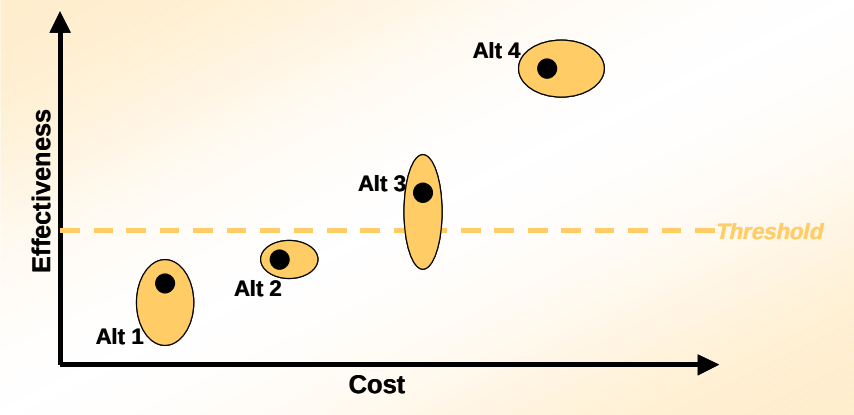

Figure 8-1 : Dilemma 1: Is the Increase in Effectiveness Worth the Increase in Cost?

results are known, choosing to apply the weight themselves rather than allowing the analyst to apply the weighting. To aid this process, the analyst should show the raw values for the MOE results, without weighting; this would remove any question of biasing the results for any alternative, and allow the decision-maker to do the weighting.

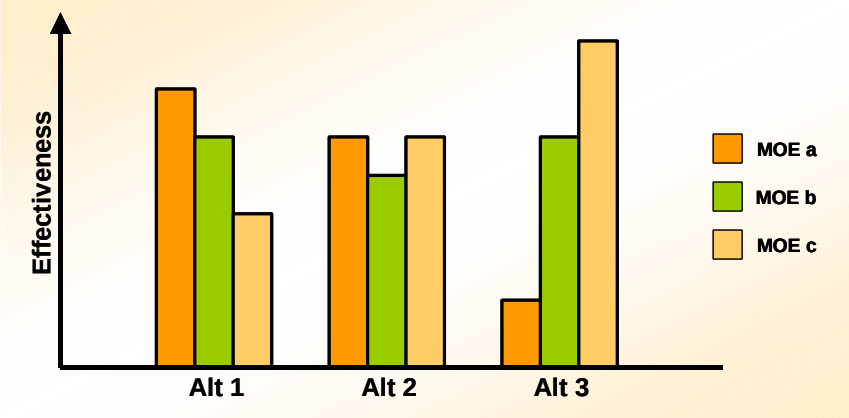

Figure 8-2 : Dilemma 2: Do These Three Alternatives Really Have Significant Differences in Overall Effectiveness?

The error bands representing the uncertainty of the point estimates for cost and effectiveness complicate the issue even further. For example, the error band surrounding Alternative 3 indicates that it may not achieve the effectiveness threshold when the uncertainty of the estimate is considered. Similarly, Alternative 4's costs may be even greater than the point estimate indicates. Often when these uncertainties are considered the differences in cost and effectiveness may be substantially reduced or eliminated, making it even more difficult to differentiate between alternatives. This is particularly true for an AoA I, when estimates of cost and effectiveness have the most uncertainty.

In this chapter we focus on the cost-effectiveness comparison process, what it should and shouldn't be, and how to make sense of it. Our guiding principle will be that the one and only goal of the process is to identify the most promising candidates for consideration by decision-makers.

Equal Effectiveness Or Equal Cost?

Equal Effectiveness

Cost-effectiveness comparisons are made most easily if all alternatives are configured to produce equal effectiveness. The analysis is then reduced to a simple cost comparison. Unfortunately, equal effectiveness is usually difficult—if not impossible—to define because of the number and complexity of AoA issues.

For example, suppose an AoA is comparing alternative munition effectiveness against a class of targets. We might propose equal effectiveness means killing a fixed percentage of the targets in a fixed time. While this may sound reasonable, it raises questions:

- What if some munitions require more sorties to meet the goal than the force can generate?
- What if the delivery of the different types of munitions results in significantly different aircraft attrition rates?
- What if the delivery of the different types of munitions results in differing rates of kill of other targets in theater due to a shift of resources?

Almost surely, all these or other significant "what ifs" will arise and erase any perception of equal effectiveness.

Equal Cost

An alternative to the equal effectiveness approach is the equal cost approach. In this instance, a straightforward comparison of alternatives is possible because all alternatives are designed with equal cost. In general, however, this is as difficult to implement as equal effectiveness.

We can see this using the same goal proposed for the equal effectiveness discussion: killing a class of targets in theater. We will assume that it is possible to set a fixed value for life cycle cost and calculate the number of munitions bought for each alternative based on this value. Unfortunately, we have to face "what ifs" similar to those raised in the equal effectiveness case.

Effectiveness vs. Cost

The obvious alternative to the generally unattainable equal effectiveness or equal cost ideal is a scatter plot of effectiveness versus cost (or vise versa) as in Figure 8-1. As we have implied, however, this seldom gives an unambiguous answer. Worse, it implies that the dilemma illustrated in Figure 8-2 has been solved and effectiveness has been successfully reduced to a single number through weighting—a practice we strongly discourage. So what do we do?

Figure 8-3 suggests typical procedures an AoA I might use to reduce the original set of potential alternatives to a small set of viable alternatives for decision makers to consider. In some cases the reduced set will contain only a single alternative. In other cases, there will be

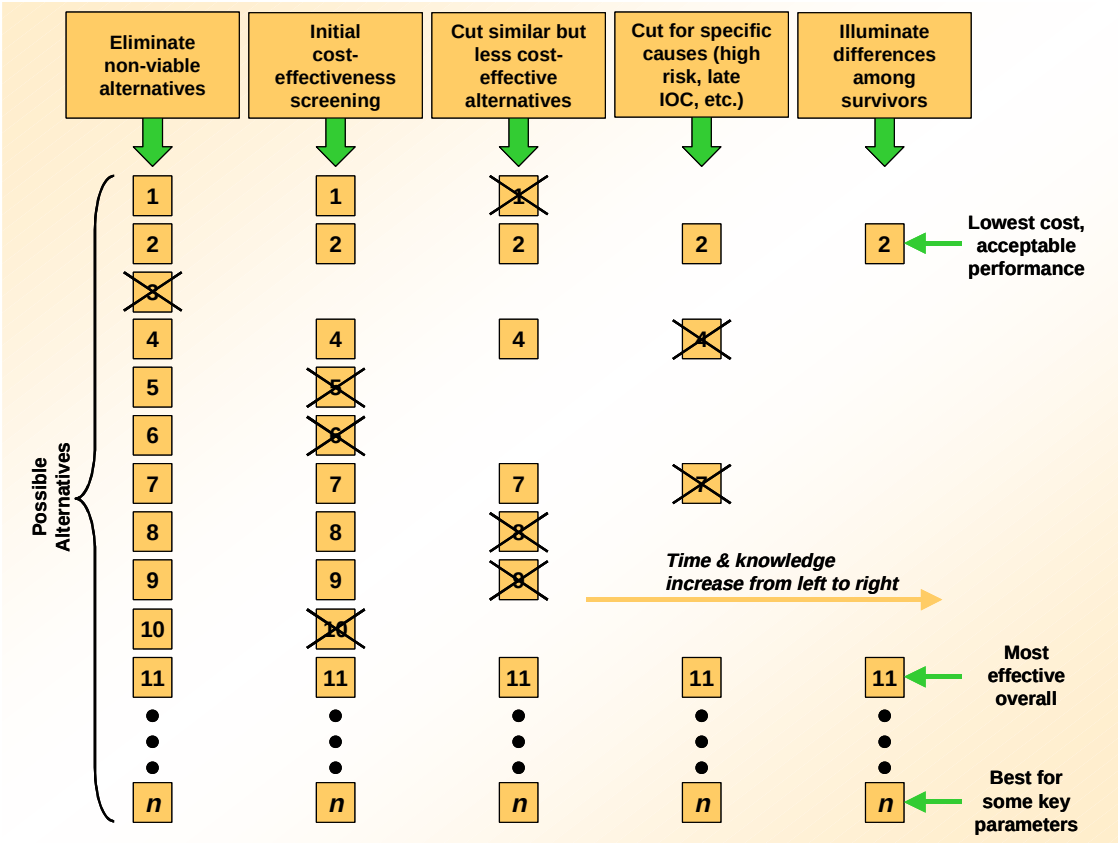

Figure 8-3 : An Example of the Art of Eliminating Alternatives in an AoA I

several alternatives, each with different cost and effectiveness pluses and minuses. Remember: *there is generally no requirement for an AoA to identify a single most cost-effective solution*.

The Art of Eliminating Alternatives

Figure 8-3 shows how an original set of alternatives is reduced to a small number of serious contenders. There is no formula for doing this; it is an art whose practice benefits from experience, and each AoA must adapt its methods to circumstances. A constant, however, is the need to document the reasons and rationale for eliminating each alternative from further consideration. This audit trail may be very important in the event the results of the AoA are questioned later.

In AoAs with few alternatives, all may be carried through to the final assessment. When there are many alternatives, it is often necessary to screen alternatives early to limit the number considered in detail later.

In all analyses, the study team's understanding of the issues and the techniques to deal with them increases as the study progresses. The same is the true for alternatives, especially in an AoA I where many alternatives are poorly understood concepts at the beginning. As the AoA progresses, these concepts are often reengineered to reflect better understanding of requirements, technologies, threats, and scenarios. Improved performance and lower cost usually accompany these changes—thus alternative cost and effectiveness are moving targets. The uncertainty can be limited by setting a cutoff date for concept redefinition, but remember that the charter of the AoA is to find the most cost-effective alternatives, not the most cost-effective alternatives defined up to an arbitrary time. Thus, the AoA should revisit discarded alternatives from time to time when new information promises significantly increased attractiveness. This is most important when a large number of concepts have been screened early in the AoA.

Non-Viable Alternatives

The first screening eliminates non-viable alternatives, alternatives that do not adhere to the ground rules of the study. You should identify them in the study plan and indicate the reasons for their elimination. Occasionally, a non-viable alternative may be carried forward to provide a reference point. Criteria defining non-viability are frequently defined in the ADM or PMD. They often reflect political considerations: the environment, world opinion, treaty compliance, desired IOC, etc.

Preliminary Screening

When a preliminary screening is necessary, it is usually done with limited data derived for alternatives whose definitions are still in transition. This suggests erring on the conservative side by giving alternatives the benefit of any doubt. The exact screening criteria will depend on available analysis resources, the number of alternatives to be carried forward, the perceived uncertainty in cost and effectiveness estimates, and a host of other factors such as similarity of alternatives, advocacy for alternatives, and technology maturity. Other factors that might be considered are sensitivity of system performance to key assumptions, vulnerability to countermeasures, flexibility in future scenarios, contributions to longer-term goals, reliability and maintainability, and time phasing of resource requirements.

The best selection criteria may not be obvious, but they can usually be deduced from the MNS, high level AoA direction, and the experience and expectations of the warfighters. This is a step in an AoA when there is a premium on rational, creative thinking.

Later Screening

As the AoA progresses and more reliable cost and effectiveness data become available there will be opportunities to do additional ad hoc screening. This is typically done on a case-by-case basis using any appropriate criteria. For example, one of two alternatives may be demonstrated to be more costly or less effective than the others; if it has no redeeming qualities it can be removed. Another system may be very sensitive to a key parameter, indicating excessive risk in performance; it may go as well.

Final Selection

There comes a time in the AoA when the remaining alternatives all have positive attributes that make them attractive in some way (think of a scatter plot similar to Figure 8-1); they are all true contenders.

The next step is to find a way to clearly state for the decision-makers the advantages and disadvantages of each, especially how the alternatives address the MNS requirements and satisfy high-level guidance. In doing this, the final selection may also consider the impact of risk to help or support the final selection of the preferred alternative(s).

Another approach for the final selection is to use the minimum acceptable threshold for critical MOEs, choosing the preferred alternative(s) based on whether or not the alternative meets or exceeds the threshold for all critical MOEs.

Any process should present a clear, unbiased picture of the analysis results, findings and recommendations. The more straightforward and clearly told the story, the easier it becomes to understand the differences among the alternatives. Even with all cost and effectiveness results in hand, it is not unusual for this final story to take several weeks or more of intense effort to develop. Again, rational thinking plays an indispensable role.

In some cases this final assessment may point to a single "recommended winner." In other cases, no such clear-cut conclusion emerges. In either event, the decision-maker will have the best available information and understanding of the alternatives that the AoA can provide.

Cost-Effectiveness Dos and Don'ts

Sensitivity Analysis

Alternatives whose performance is stable over a range of conditions are more adaptable than those lacking such stability. Alternatives in an AoA are typically defined with certain appropriate assumptions made about their performance parameters: weight, volume, power consumption, speed, accuracy, impact angle, etc. These "monolithic" alternatives are then assessed against AoA-defined threats and scenarios under a set of AoA-defined assumptions. This provides very specific cost and performance estimates, but does little to assess the stability of alternative performance to changes in system parameters or AoA threats, scenarios and assumptions.

Stability can only be investigated through sensitivity analyses in which the most likely critical parameters are varied: reduced speed or increased weight

Table 8-1 : Cost-Effectiveness Matrix

MOE Summary									Decision Cost BY94 $(M)
Critical						Non-Critical			
MTs:	1 Air Superiority			2 Supportability		3 Interoperability			
MOEs:	1-1	1-2	1-3	2-1	2-2	3-1	3-2	3-3	
Alt 1									
Alt 2									
Alt 3									
Alt 4									

or greater or less accuracy. This form of parametric analysis can often reveal strengths and flaws in alternative performance that are valuable in making decisions to keep or eliminate alternatives from further consideration.

Sensitivity analyses should be performed whenever time and resources allow, with an emphasis on alternatives that survived early screening processes. Of course, it is always necessary to balance the amount of sensitivity analysis against its potential value and the available resources.

Provide the Basic Cost and Effectiveness Data

Provide basic life cycle cost and MOE effectiveness data for all candidate alternatives that have been analyzed. Table 8-1 shows a straightforward format for presentation. By its nature, these data are fundamental to understanding the logic of any additional winnowing of alternatives.

Avoid Using Ratios for Comparisons

Ratios—cost/kill, kills/sortie, etc.—are frequently proposed for comparing alternatives. Unfortunately, ratios can be misleading because they frequently hide necessary information.

As an example, suppose that one alternative kills 0.01 targets per sortie and a second alternative kills 0.1 targets per sortie. The second alternative is ten times better than the first, right? That sounds significant, but is it...?

The truth is, we can't tell from the ratio alone. If there are 10 targets to be killed, the answer is likely to be a resounding yes—100 sorties may be acceptable, but probably not 1,000. However, if there are 1,000 targets to be killed, the answer is almost certainly no, for we are looking at very large numbers of sorties even for the better alternative.

By using the ratio instead of the numbers of sorties required, there has been a loss of understanding without a corresponding gain of any sort.

9 Final Results

The final results of an AoA are presented initially in a series of briefings. For an ACAT I program, the briefings are typically given to the CPIPT, AFROC, AFC, OIPT, and DAB.

The purpose of the briefings is to logically present the case for selection of the best alternative(s) in meeting the mission needs in the MNS. The quality of the presentations—and perhaps more so, the quality of the underlying AoA work—is critical to the initiation or continuation of the program.

In addition to the final briefings, the entire AoA process and results must also be documented in a written final report. This report, approved by the MAJCOM, is due 180 days after the presentation of the final results. This is an important volume, for it is the principal supporting documentation for any decisions made as a result of the AoA. It also may be the basis for any subsequent AoAs at later milestones and different (but similar) AoAs in the future.

The final report should follow the same format as the study plan (in Chapter 4), with the addition of these sections:

5.4 Effectiveness Results
6.4 Life Cycle Cost Results
7.3 Cost-Effectiveness Results
7.4 Recommendation of Preferred Alternative(s)

This format corresponds closely to that of the study plan to help adapt material from the study plan to the final report.

Criteria for Assessing the Final Results

The criteria used to judge the adequacy of the both the briefings and report are in Appendix B. One of these criteria clearly states that the conclusions of the briefings and report must be supported by the results of the AoA's cost and effectiveness analyses. To this end, throughout this handbook we have strongly supported the need to present the unadulterated individual MOE values and basic life cycle cost results, no matter in what other form this information is presented. This is critical because any rationale and its subsequent conclusions in a briefing (or the report) must be compatible with this basic data.

We have also strongly discouraged the weighting of MOEs and admonished against rolling up data when the roll up does not obviously contribute to a better understanding of the comparison of the alternatives.

Advocacy

It is important to keep in mind that the AoA does not make a decision; it develops information and makes a recommendation. This information is used in conjunction with other significant information to allow the Milestone Decision Authority or other decision-maker to make a choice, which may differ, from the recommendation. Thus, it is best if presenters of the final results advocate the completed AoA process and its results, not a particular solution.

Appendix A: Study Plan Assessment

This appendix contains the AoA study plan assessment criteria used by OAS in our independent assessment of study plans to the AFROC.

In general, the study plan must be complete; the study plan details are not always available, but a plan for obtaining them should be. The study plan must be written for the uninitiated, be organized and concise, be grammatically correct to avoid ambiguity, and contain accurate, easy to interpret figures and tables.

What follows are eleven specific assessment criteria in a convenient checklist format:

1. Base Mission Tasks & Measures on MNS

- Derive mission tasks the MNS and other relevant guidance on requirements
- Derive MOEs from the mission tasks
- Derive MOPs from the MOEs
- Make each MOE solution independent (i.e., no MOE depends on the specifics of a subgroup of alternatives)
- Address MOE and MOP threshold requirements (if any)

2. Address Relevant Issues & Constraints

- Address PMD, ADM and any other guidance
- Discuss previous studies that might have raised important issues or defined relevant constraints
- Discuss key milestones for the AoA
- Make differences in time of availability of the alternative solutions clear

3. Use a Comprehensive Range of Alternatives

- Define the baseline alternative
- Consider a reasonable range of alternatives
- Discuss the screening criteria for selecting and excluding alternative solutions
- Describe each alternative solution

4. Use Reasonable Operational Concepts

- Outline employment concepts (basing, deployment, tactics, limitations, etc.)
- Consider logistics concepts (maintenance, supply, personnel, etc.)
- Identify interdependencies with existing operational support systems (navigation, communications, weather, etc.) and key support systems (defense suppression, escort, etc.)

5. Use Realistic Threats & Scenarios

- Discuss nature and sources of threats and scenarios
- Discuss threat and scenario validation
- Discuss threat variations with time
- Discuss integration of threats into scenarios
- Identify threat and scenario aspects most influential to outcome of the analysis
- Discuss possible reactive countermeasures to each alternative
- Consider contributions of other services and our allies
- Consider a broad range of environmental and hostile operating environments

6. Link Measures with ORD & TEMP

- Ensure key MOEs & MOPs are measurable/testable and that they support development of the ORD and TEMP

7. Use Sound Top Level Methodology

- Discuss integration of effectiveness, cost, and cost effectiveness methodologies
- Discuss the ability of the effectiveness analysis to differentiate among alternatives
- Discuss the suitability of the "level of analysis" (mission, campaign, etc.)
- Discuss the ability of cost-effectiveness methodology to differentiate among alternatives

- Outline decision criteria for making the final selection
- Discuss sensitivity analyses addressing threats, alternative performance, etc.
- Identify AoA resources required to execute the methodology
- Identify methodology shortcomings

8. Use Acceptable Effectiveness Models & Methodology

- Discuss effectiveness assumptions
- Identify existing effectiveness models needed for the analysis
- Identify new models needed for the analysis
- Identify model functions and reasons for selection
- Identify major inputs and outputs of each model
- Identify model limitations
- Discuss needed model modifications
- Illustrate interrelationships among models, mission tasks, MOEs, and MOPs

9. Use Acceptable Cost Models & Methodology

- Focus on life cycle cost (LCC) analysis of alternatives
- Discuss costing assumptions
- Identify cost models to be used
- Discuss model functions and reasons for selection
- Identify major inputs and outputs of each model
- Identify model limitations
- Discuss interrelationships of models
- Discuss needed model modifications
- Identify sources for model inputs
- Outline cost review process
- Discuss the cost risk methodology
- Discuss appropriate CAIV methodology for the AoA phase

10. Use Appropriate VV&A

- Discuss model and data accreditation procedures (see AFI 16-1001)

11. Use a Reasonable Schedule with Acceptable Risk

- Include a schedule
- Identify available resources (money, manpower, expertise)
- Assess the ability of the AoA study team to execute the study plan
- Discuss potential roadblocks (new model or methodology development, lack of data, etc.)

Appendix B: Final Results Assessment

This appendix contains the AoA final results assessment criteria used by OAS in our independent assessment of study plans to the AFROC; the list is again in a convenient checklist format.

1. Follow the Important Aspects of the Study Plan

- Deviations from the planned effectiveness and cost analyses are understood and conform to AoA study plan standards
- Address oversight guidance

2. Review the Nature and Sources of Threats and Scenarios

- Address threat and scenario validation

3. Conduct Reasonable V&VA

- Get the accreditation report covering model V&V and data certification signed

4. Use Reasonable Final Operational Concepts

- Have the warfighter sanction employment concepts (basing, deployment, tactics, limitations, etc.)
- Verify the viability of logistics concepts (maintenance, supply, personnel, etc.)
- Account for interdependencies with existing operational support systems (navigation, communications, weather, etc.) and key support systems (defense suppression, escort, etc.)

5. Successfully Execute the Effectiveness Methodology

- Determine the military worth of alternatives
- Discuss effectiveness assumptions
- Evaluate a range of independent alternatives for the final analysis
- Give a convincing rationale for early elimination of alternatives

6. Successfully Execute the Cost Analysis Methodology

- Discuss costing assumptions
- Identify sources for cost inputs
- Summarize the cost review process
- Present cost results by alternative
- Discuss CAIV implications

7. Support the AoA Findings with the Presentation

- Discuss the ability of the cost-effectiveness methodology to differentiate among alternatives
- Outline decision criteria for making the final selection
- Present cost-effectiveness results at the MOE level and at higher levels of aggregation if appropriate
- Present and interpret sensitivity analyses addressing the threats, alternative performance, etc.
- Identify and interpret methodology shortcomings relative to each alternative
- Support all AoA conclusions with briefed results

Appendix C: Acronyms

ACAT	Acquisition Category
ACTD	Advanced Concept Technology Demonstration
ADM	Acquisition Decision Memorandum
ADUSD	Assistant Undersecretary of Defense
AF	Air Force
AF/IN	Assistant Chief of Staff for Intelligence
AF/XOC	Director of Command and Control
AFC	Air Force Council
AFCAA	Air Force Cost Analysis Agency
AFCAIG	Air Force Cost Analysis Improvement Group
AFI	Air Force Instruction
AFROC	Air Force Requirements Oversight Council
AFSAA	Air Force Studies and Analyses Agency
AHP	Analytical Hierarchy Process
ALC	Air Logistics Center
AoA	Analysis of Alternatives
APB	Acquisition Program Baseline
AVCSAF	Assistant Vice Chief of Staff Air Force
BY	Base Year
BY$	Base Year Dollars
C4I	Command, Control, Communications, Computers, and Information
CAE	Component Acquisition Executive
CAIG	Cost Analysis Improvement Group
CAIV	Cost as an Independent Variable
CARD	Cost Analysis Requirement Description
CCA	Component Cost Analysis
CCB	Configuration Control Board
CE	Concept Exploration
CE	Civil Engineering
CER	Cost Estimating Relationship
CIO	Chief Information Officer
CIPT	Cost Integrated Process Team
COE	Center of Expertise
COEA	Cost and Operational Effectiveness Analysis
CONOPS	Concept of Operations
COTR	Contracting Office Technical Representative
CPIPT	Cost Performance Integrated Product Team
CSAF	Chief of Staff Air Force
CSEL	Combat Survivor Evader Locator
CWG	Cost Working Group
DAE	Defense Acquisition Executive

DASD	Deputy Assistant Secretary of Defense
DIA	Defense Intelligence Agency
DoD	Department of Defense
DPA&E	Director of Program Analysis and Evaluation
DPG/IPS	Defense Planning Guidance/Illustrative Planning Scenario
DT&E	Developmental Test & Evaluation
EMD	Engineering and Manufacturing Development
EW	Electronic Warfare
FASA	Federal Acquisition Streamlining Act
FFRDC	Federally Funded R&D Center
FOC	Full Operational Capability
GPS	Global Positioning System
HSC	AFMC Human Systems Center
ICE	Independent Cost Estimate
IIPT	Integrating Integrated Product Team
ILSP	Integrated Logistics Support Plan
IOC	Initial Operational Capability
IPT	Integrated Product Team
ISR	Intelligence, Surveillance, Reconnaissance
JCTD	Joint COEA Tasking Directive
JPALS	Joint Precision Approach and Landing System
JROC	Joint Requirements Oversight Council
LCC	Life Cycle Cost
LRIP	Low Rate Initial Production
M&S	Models & Simulations
MAA	Mission Area Assessment
MAISAP	Major Automated Information Systems Acquisition Programs
MAISRC	Major Automated Information Systems Review Council
MAJCOM	Major Command
MAP	Mission Area Planning
MDA	Milestone Decision Authority
MDAP	Major Defense Acquisition Program
MER	Manpower Estimate Report
MILCON	Military Construction
MIL-STD	Military Standard
MNA	Mission Need Analysis
MNS	Mission Need Statement
MOA	Memorandum of Agreement

MOE	Measure of Effectiveness
MOP	Measure of Performance
MOU	Memorandum of Understanding
MPTS	Manpower, Personnel, Training & Safety
MSA	Mission Solution Analysis
MSFD	Multi-Spectral Force Deployment
MT	Mission Task
O&S	Operations and Support
OAS	Office of Aerospace Studies
OC	Operating Command
OC/FM	Operating Command Financial Management
OIPT	Overarching Integrated Product Team
ORD	Operational Requirements Document
OSD	Office of the Secretary of Defense
OSD/DPA&E	OSD/Director of Program Analysis and Evaluation
OT&E	Operational Test & Evaluation
P3I	Pre-Planned Product Improvement
PAT	Process Action Team
PDRR	Program Definition and Risk Reduction
PEM	Program Element Monitor
PEO	Program Executive Officer
PF/DOS	Production, Fielding/Deployment & Operational Support
PMD	Program Management Directive
POC	Point of Contact
POE	Program Office Estimate
R&D	Research and Development
RCM	Requirements Correlation Matrix
RDT&E	Research, Development, Test & Evaluation
ROC	Required Operational Capability
SAE	Service Acquisition Executive
SAF/AQ	Assistant Secretary for Acquisition
SAMP	Single Acquisition Master Plan
SCP	Service Cost Position
Sec AF	Secretary of the Air Force
SETA	Scientific, Engineering, Technical, and Analytical
SG	Surgeon General
SON	Statement of Operational Need
SOO	Statement of Objectives
SOW	Statement of Work
SPD	System Program Director
SPO	System Program Office
STA	System Threat Assessment

STAR	System Threat Assessment Report
TAR	Threat Assessment Report
TEMP	Test and Evaluation Master Plan
TOR	Tentative Operational Requirement
TPD	Threat Planning Document
TRG	Technical Review Group
TY	Then Year
TY$	Then Year Dollars
UAV	Unmanned Aerial Vehicle
USD(A&T)	Undersecretary of Defense for Acquisition and Technology
VCSAF	Vice Chief of Staff Air Force
VV&A	Validation, Verification, and Accreditation
WBS	Work Breakdown Structure
WG	Working Group
WIPT	Working-Level Integrated Product Team
XR	Product Center